Alberta Research Council Annual Report 1985

The Alberta Research Council is a crown corporation of some 600 employees supporting industry and government through a broad range of research in science and technology, with applications in energy, agriculture, forestry, environment, natural resources, industrial assistance and new technologies. The Alberta Research Council's headquarters are in Edmonton with offices in Calgary, Devon, Red Deer, Nisku and Lethbridge.

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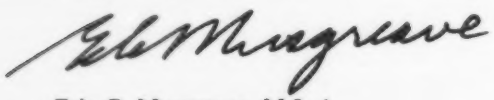
ALBERTA RESEARCH COUNCIL

Letter of transmittal

To The Honorable Don Getty
Premier of the Province of Alberta

In accordance with the requirements of the Alberta Research Council Act, I have the honor to present to you the Annual Report of the Alberta Research Council for the calendar year 1985.

Respectfully submitted,



Eric C. Musgreave, M.L.A.,
Chairman of the Board
Alberta Research Council

April 1986

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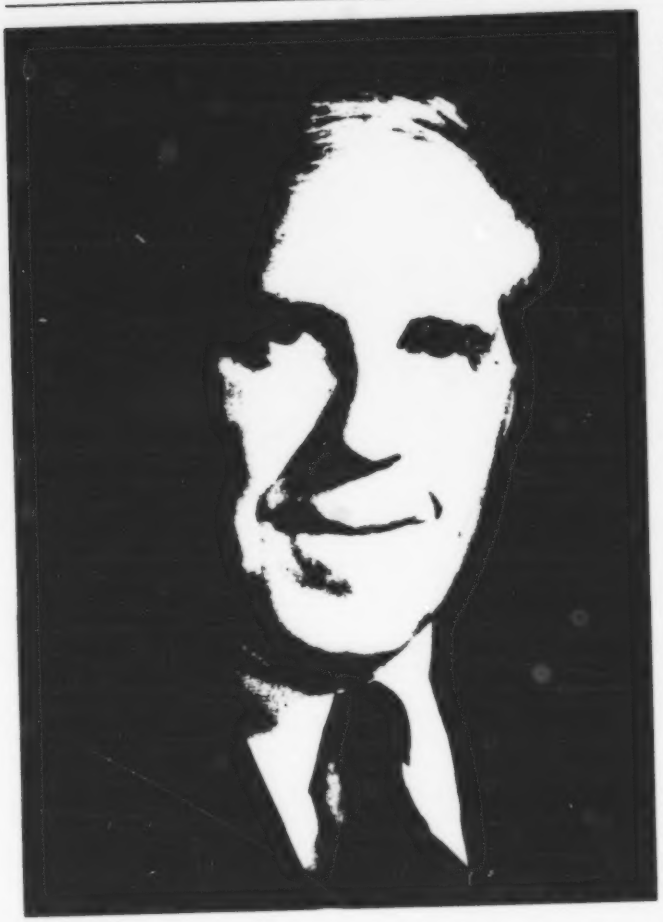
A technologist at the Electronics Test Centre sets up the automated test system in the radio frequency anechoic chamber used to measure electro-magnetic interference.

Chairman's message

The Board of Directors has given a high priority to biotechnology as an important, new area of research.



The considerable planning and construction of facilities and movement of staff at the Alberta Research Council in recent years has resulted in a substantial increase in our ability to serve Alberta industry. In Calgary, the staff of our regional office for southern Alberta has expanded to 30 employees, mainly in establishing our provincial base of operations for the Advanced Technologies and Industrial Development departments. That office was officially opened on November 28, in cooperation with the Calgary Research and Development Authority.

The $22 million Coal Research Centre Devon officially opened on September 13, combining the expertise and facilities of three coal research organizations — the Alberta Research Council, the CANMET Coal Research Laboratory of Energy, Mines and Resources Canada, and the Coal Mining Research Company.

The Electronics Test Centre, which officially opened on December 5 at the Research Council's new building in southeast Edmonton, is now working on contracts to serve the Canadian electronics industry with a wide range of tests for national and international certification.

The Board of Directors has given a high priority to biotechnology as an important, new area of research. I am pleased to report that the biotechnology pilot plant started operations at the new building in Edmonton. Furthermore, the Government of Alberta allocated funding to upgrade this pilot plant into the only full range biotechnology toll facility for industrial use in Canada.

The Board had another active year, meeting in Fort McMurray, Devon and Calgary, in addition to its regular meetings in Edmonton. Because the Alberta Research Council serves clients in industry and government throughout the province, the Board finds that meeting in various communities is useful in better understanding the needs of these communities.

We have a close working relationship with Alberta's universities and conduct a variety of projects in southern Alberta, so it was a pleasure to welcome to our Board Dr. Ian Newbould, Dean of Arts and Sciences and Interim Director of Research Administration at the University of Lethbridge.

On behalf of the Board, I express our deep regret on the death of Dr. Robert Hardy, a leader in the Canadian engineering field, who retired from the Board in 1984 after long and valuable service to the Alberta Research Council.

To communicate our work with industry and government more effectively, we have changed the format of this year's annual report. Our activities for 1985 are reported by the economic sectors to which they mainly or entirely contribute, rather than by the titles of our research programs. We hope this change will give the readers of this report a clearer understanding of how we contribute to the present and future economic development of Alberta.

Eric C. Musgreave, M.L.A.
Chairman of the Board of Directors

President's report

Many projects which have been dreamed, discussed and planned — some of them for years — came to fruition in 1985. On the other hand, there was a satisfying list of new initiatives as "seeds planted," and with confidence we can expect future years to yield their share of harvests.

Various official openings took place: the Coal Research Centre Devon, our Calgary offices, and the Electronics Test Centre. Although we did not complete our planned move into our new building in southeast Edmonton because of some delays in outfitting, a trickle of occupation did begin. The move should be completed early in 1986. The people of Alberta, through their government, have provided us with superb facilities. It is our task and opportunity to show that they have invested well.

The Alberta Research Council works in a variety of ways towards its general objective of enhancing the Alberta economy. None is more important than the transfer of technology.

One example of our success in transferring technology to industry is International Permeation Inc. (IPI), a company formed in Calgary to commercially exploit the membrane technology for gas separation developed at the Research Council and funded at the pilot stage by the Alberta/Canada Energy Resources Research Fund. Formerly Alberta Helium Limited, IPI is a company restructured to reflect a stronger commercial direction led by its major shareholders; Alberta Natural Gas Limited; Cancarb Limited, a subsidiary of TransCanada PipeLines Ltd; and Delta Projects Ltd., a Calgary engineering design and procurement company with experience in membrane systems. The Alberta Research Council is also a shareholder, our shares having been earned by the technology we have transferred to the company.

One example of our success in transferring technology to industry is international Permeation Inc. (IPI), a company formed in Calgary to commercially exploit the membrane technology for gas separation developed at the Research Council.

Perhaps even more important than the original objective of separating helium from a natural gas stream, was that of developing the membrane technology to sweeten sour gas and recover hydrogen, which is important to upgrading, treating and processing heavy oil and bitumen in this province. Dr. Harry Habgood, who retired last year, and Dr. C.Y. Pan, of the Materials and Testing Department, developed the technology. It was my pleasure on December 18 to present to these gentlemen, as well as to Mr. Earl Hadfield and Mr. Marty Schurek, who had provided essential technical support, substantial awards for outstanding achievement in research.

The organizational changes and moves of staff to Calgary last year have better enabled us to serve industry. The Advanced Technologies Department has established its Information Technologies section, dealing with expert systems and participant systems, and its Automation Technologies section, dealing with robotics and design automation. We expect this initiative to answer needs of our clients throughout Alberta regarding microelectronics and computing.

Our Joint Research Venture program is the third component of the Advanced Technologies Department. Thanks to a special injection of provincial government funds, it was able to expand during the year with the addition of three new projects with Calgary firms: Q.C.

The progress of the Electronics Test Centre in our new building in Edmonton has been encouraging. Despite its early stage of development, the Test Centre has already arranged over $200 000 in contracts. It also spent much of the year negotiating accreditation by national and international electronics standaras organizations.

Data Collectors Ltd.; Veritas Software Ltd.; and D&S Petroleum Consulting Group Ltd. These projects are good examples of support for newer companies servicing Alberta's major industries, and establishing export markets. Such efforts supplement our support of the major industries themselves.

In an effort to improve coordination of federal and provincial support for industry, we have tightened our links with the National Research Council. Its regional representative is now serving as Head of our Industrial Development Department.

The biotechnology pilot plant started operations during the year in our new building in southeast Edmonton. A contract with BIO-FROST Inc., of Hamilton, Ontario, was completed for the commercial scale-up technology of a product to help produce artificial snow. We were able to take technology up to the 1500-litre fermentor stage. It was greatly encouraging to receive from the Government of Alberta a further $2.6 million investment in this pilot plant to develop a biotechnology toll facility. The only facility of its kind in Canada and only the third in North America, it will allow biotechnology companies to test processes on a commercial scale, up to the 15 000-litre stage. We expect this facility to be a great advantage for Alberta and Canadian industry involved in the diverse applications of biotechnology.

The progress of the Electronics Test Centre in our new building in Edmonton has been encouraging. Most of the year has been devoted to building laboratory space as well as installing and commissioning equipment. Despite its early stage of development, the Test Centre has already arranged over $200 000 in contracts. It also spent much of the year negotiating accreditation by national and international electronics standards organizations to allow local, competitively-priced testing of electronics products from western Canada to meet the standards of national and international markets.

In the natural resources area, the weather modification research program completed its current five-year mandate to investigate whether or not cloud seeding can effectively reduce the destructive impact of hail, and increase rainfall and snowfall where needed. Largely with the funding of Alberta Agriculture, researchers in this program have made great strides in formulating and testing hypotheses relevant to the making of economically feasible recommendations on operational weather modification. We look forward to continued support from the Government of Alberta to be able to continue this program.

We have completed a major study on the hydrogeology of the Cold Lake area prior to its exploitation by in situ oil sands recovery operations, so that we will be able to advise government and industry on the impact of these operations. We have also completed reports on Alberta's metallic and industrial minerals and a major report on the aggregate resources of the province.

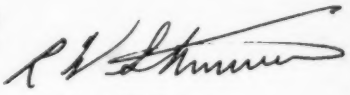
Our major research program in bitumen and heavy oil recovery continued with particular emphasis on the Cold Lake oil sands deposits. Our longstanding and fruitful relationship with the Alberta Oil Sands Technology and Research Authority has been continued and strengthened. At the same time, we are further developing our direct relations with private sector companies. Notably, we signed a new research contract with Texaco Canada Resources Ltd., continuing a business relationship which started in 1971.

The Coal Research Centre Devon officially opened in September, forming a cooperative and productive team with Energy, Mines and Resources Canada's CANMET Coal Laboratory and the Coal Mining Research Company.

Among the many achievements of our staff during the year was that of Dr. John Kramers who received the Geological Survey of Canada Service Award. Dr. Mike Kessick and Dr. Alan Sanger were appointed Fellows of the Chemical Institute of Canada and Helga Radvanyi-Starr became President of the Canadian Institute of Energy.

Finally, I extend best wishes and thanks for their contributions to Dr. John Godfrey and Mrs. Gladys Stott, two long-time and valued employees who retired during 1985.

Our active Board of Directors, as always, provided wise direction to the Alberta Research Council. Their support and guidance is greatly appreciated.



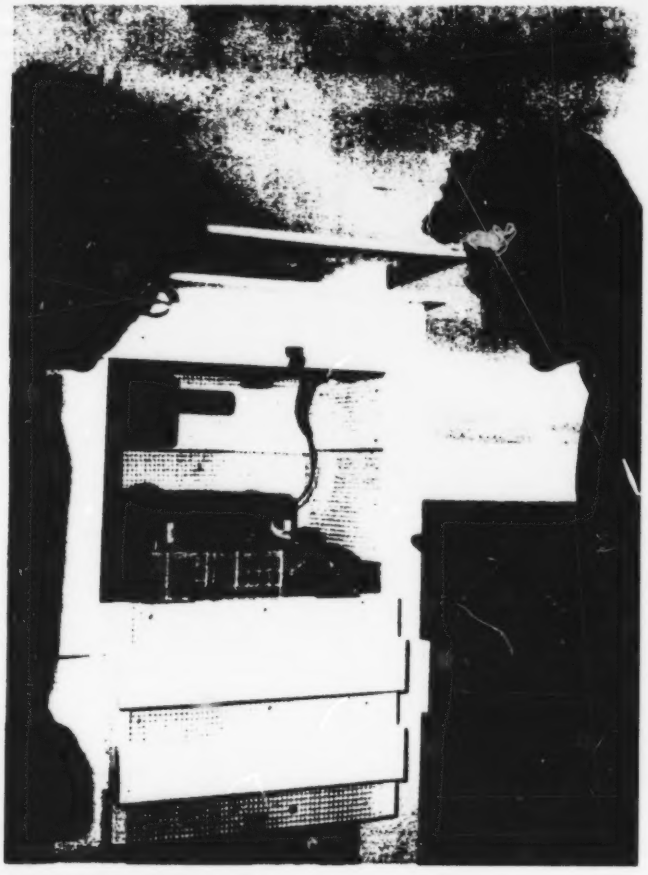
Robert W. Stewart
President

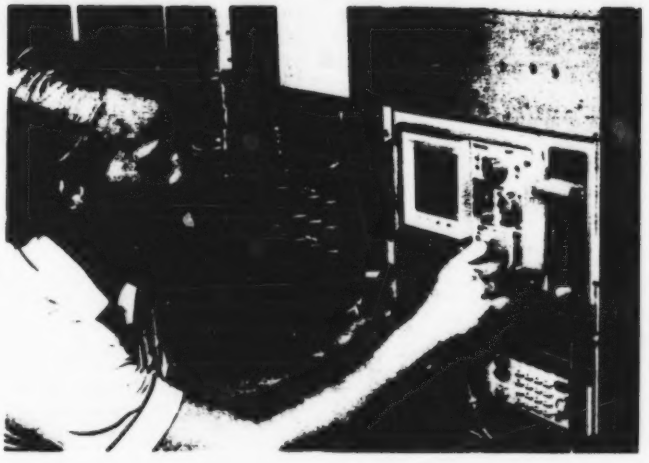
Human resources

The results of some projects at the Alberta Research Council are not likely to pay off for another 10 or 20 years. Productivity under those circumstances is difficult to measure. It is clear, however, that the Research Council has contributed and is still contributing in many ways and varying degrees to the economy of Alberta. The effectiveness of our contribution now and in the future depends of course on the capabilities of our employees.

We have a creative and industrious staff of professional researchers, technologists and managers who contribute a wide range of experience from all corners of the world. In both pure and applied science, our staff has been working directly with Alberta companies and government departments to solve problems and create new opportunities.

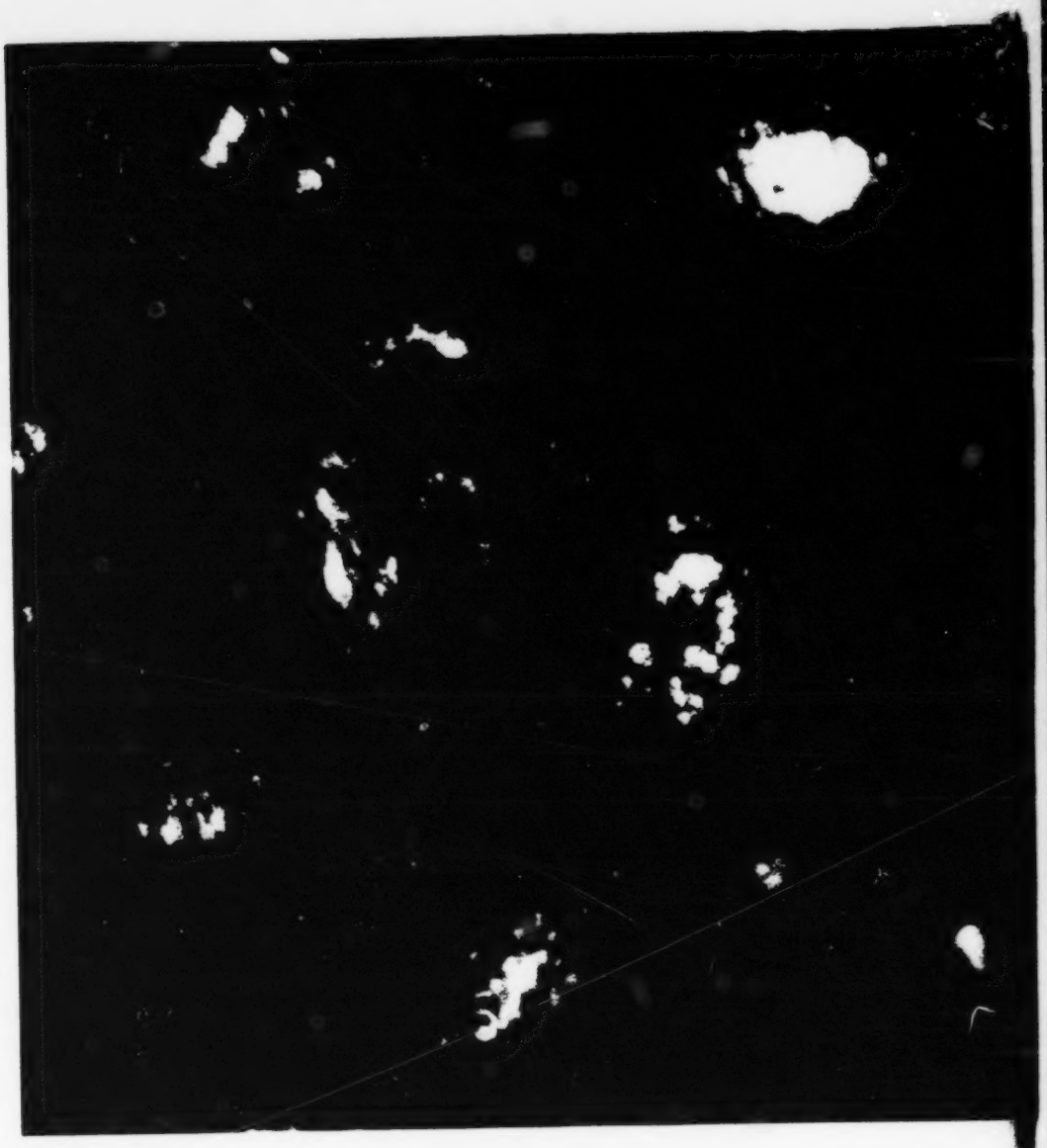
Our staff in the research departments and support services share the common goal of making the business of research and development profitable for Alberta. The strength of this organization is truly its people, who are working together to conduct research and disseminate information on scientific and industrial research programs for today and for future generations.





Management, research and support staff, such as those in biotechnology (above), terrain sciences (top right) and atmospheric sciences (right) are developing new opportunities for the industry and people of Alberta.

Our staff in the research departments and support services share the common goal of making the business of research and development profitable for Alberta.



Nickel was found (shown at 40X magnification) to be an effective coating for sand in retarding the dissolution of gravel packs at the bottom of steam-injection wells.

Researchers made major advances in sampling methodology and in applying geochemical computer codes to calculate mineral reaction sequences in core flood experiments. This expertise generated more than $300 000 worth of contract work during the year.

Energy

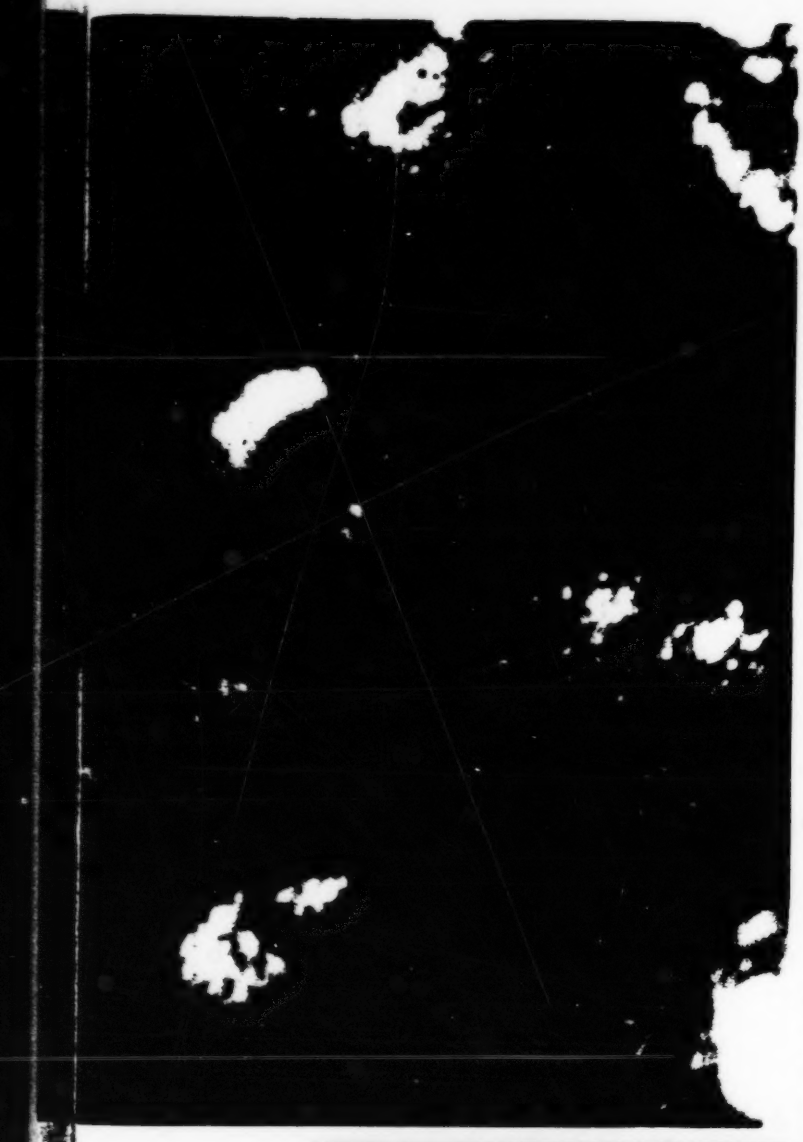
Oil sands

Bitumen from Cold Lake oil sand is likely to contain dissolved gases and is referred to as "live", whereas bitumen that contains no dissolved gases is referred to as "dead". Researchers conducted three tests on dead oil—one process with steam only and the other two with steam and carbon dioxide. They also conducted four tests on live oil pre-saturated with methane—one with steam only, two with steam and carbon dioxide, and one with steam and methane.

The steam and carbon dioxide process was more effective for dead oil than the steam only process. For live oil, however, the steam and carbon dioxide co-injection process did not improve oil recovery compared with the steam only process. Also, in the case of live oil, using slug injection, the steam and carbon dioxide process or the steam and methane was more effective in producing oil than co-injecting carbon dioxide with steam. The overall conclusions were that the dissolved gas content of oil sand has a substantial effect on recovery processes, and that different injection strategies are required for live and dead oil conditions.

Numerical modelling, which projects results of laboratory experiments to potential field applications, is an essential step in assessing the full impact of a recovery process under investigation. Numerical models could previously apply only to processes using steam and one additive. Now, at the end of five years, a computer model is complete for processes using steam and three additives. This model will allow researchers to project research results more accurately by not only providing for additional additives, but for allowing bitumen, which has a complex composition, to be described by more than one component.

Recovery processes using



Computed tomography, which was developed for use in hospitals, is now useful in studying the composition of oil sand core samples.

steam with or without additives can cause geochemical reactions with the minerals in the formation. These reactions can change the chemisty of the injected fluids, inhibiting oil production. The changed fluids can also destroy the permeability of the formation by causing clays to swell and by transporting and mobilizing fine matter.

Under a joint program with the Alberta Oil Sands Technology and Research Authority (AOSTRA), the Alberta Research Council has been developing an understanding of these reactions in order to predict and control them in the field.

Laboratory core flood experiments at high temperatures are being compared with computer model predictions of down-hole geochemistry. Researchers made major advances in sampling methodology and in the application of geochemical computer codes to calculate mineral reaction sequences in core flood experiments.

In developing the database for these models, they also made major advances in measuring fundamental thermodynamic data for important dissolved ions at in situ temperatures and pressures. This expertise generated more than $300 000 worth of contract work during the year.

The movement of fines under in situ conditions is much more difficult to predict than mass transport caused by simple mineral reactions. A computer model was developed that predicts, on the basis of the injection fluid chemistry, whether or not fines migration occurs. Although this research was conducted to improve in situ recovery operations, the theory can also be used to maximize bitumen recovery in processing surface-mined bitumen by predicting the water chemistry needed to avoid detrimental coagulation of fines.

Directing steam and injection fluids into specific areas of a formation to maximize the bitumen recovery is an economically important, but difficult, problem to solve. In working towards a solution, the Alberta Research Council has identified the necessary flow conditions for creating in situ foams in porous media that can be used to block off certain areas of the formation.

For the past four years, the research staff has been working on quantitative relationships describing the properties of bitumen containing injected recovery fluids, under the high temperature and pressure of in situ conditions. Experiments during the year were successful in measuring quantitative values for the relative permeability of bitumen, water and gases in core samples. Experiments were also conducted to develop quantitative relationships to predict the volumes of bitumen/additive systems under in situ conditions. Finally, this research has resulted in a method for predicting bitumen viscosities, an important and sensitive parameter for reservoir models.

Gravel packs, designed to filter out solids from entering the well bore at the bottom of injection wells, are usually coated with a material which will protect them from dissolving during the injection of steam and chemical additives. In conjunction with Sherritt Gordon Mines Ltd., the Alberta Research Council and AOSTRA developed a gravel pack using nickel-coated sand. Researchers tested nickel as a coating for sand against five other common gravel pack coating materials and found it to be the most resistant to dissolution under in situ injection conditions.

In the search for efficiency at every step of its operations, the oil sands industry has been studying ways to

A high-pressure cell is loaded with a coal sample inside one of the large explosion containment vessels. These vessels (inset) are located at interim high pressure coal research facilities in Nisku.

The Alberta Research Council successfully demonstrated that low-rank coals from Alberta and the United States, as well as lignites, can be beneficiated using agglomeration.

recover byproducts following bitumen and heavy oil recovery processes. The Alberta Research Council conducted a study on the properties and aging characteristics of residues following bitumen upgrading. Another study, for Texaco Canada Resources Ltd., reported on properties of bitumen from various deposits in the company's lease near Cold Lake. The changes in composition of bitumen in response to recovery processes and the effects of additives on in situ recovery were also studied.

Using technology originally developed for hospital use, researchers have applied computed tomography to study the composition of oil sand core samples. They can determine the amount of sand, water and oil inside a field core and can conduct experiments in the displacement of heavy oil and bitumen. The computed tomography equipment, acquired from the University of Alberta Hospital in Edmonton and the Foothills Hospital in Calgary, was commissioned in 1985.

As the international trend in developing oil sands technology has moved towards commercial scale, the activity of the Alberta Research Council's Oil Sands Sample Bank has increased accordingly. The sample bank shipped approximately 500 barrels of oil sand samples to pilot plants outside Canada, mainly in Japan and the United States, doubling the shipments of the previous year. The sample bank also conducted experiments on a method for advising surface-mining oil sands companies on the performance of given areas of their leases and strategies for processing oil sands from those areas. This new direction has resulted in contracts with two major petroleum companies.

Coal

Research on coprocessing of coal and bitumen has the objective of evaluating whether the process is economically more attractive than heavy oil and bitumen upgrading. With funding from the Office of Coal

Research Technology and the Canadian Coal Liquefaction Corporation, an improvement was evaluated in the technology for liquefaction coprocessing of coal and bitumen/heavy oil, developed by the Alberta Research Council. This improvement involves carbon monoxide and steam as a partial replacement for hydrogen. The results of the economic study indicated that this process was competitive with other new technologies, but was less attractive than a new German process—*Pyrosol*. Work is continuing under contract to study the suitability of the *Pyrosol* process to Alberta coals and bitumen.

Small amounts of heavy oil added to coal-water slurries produce agglomerates — balls of high quality coal up to the size of marbles — when pumped through a pipeline or stirred in a tank. The agglomeration process also results in the simultaneous beneficiation of different grades of Alberta coals by removing ash, which is detrimental to conversion processes. The Alberta Research Council successfully demonstrated that low-rank coals from Alberta and the United States, as well as lignites, can be beneficiated using agglomeration. This work was carried out under contract to the Electric Power Research Institute, a United States research organization supported by the energy industry, as well as to Pembina Resources Limited and Suncor Ltd.

Agglomeration technology has also been found effective in recovering hydrocarbons from dilute water streams, and techniques have been developed for recovering hydrocarbons from the resulting agglomerates.

Valuable petrochemical products, such as benzene and ethane, can be generated from Alberta coals by hydropyrolysis, prior to burning the coals in steam generation plants. Bench-scale tests of flash hydropyrolysis indicated that the yield of those products was two to three times greater than in a conventional pyrolysis process. Researchers also established a capability for evaluating the combustion characteristics of coal or coal chars.

With the support of the Office of Coal Research and Technology, the Alberta Research Council has improved the capability of its analytical laboratory in tracing important chemical compounds and how they change during coal liquefaction.

Hydrocarbon upgrading

Up to 25 percent of the product from Alberta oil sands plants is coke, which is unsafe to burn because of its high sulfur dioxide content. The use of calcium hydroxide in the coking process has been studied for its effectiveness in controlling the release of sulfur dioxide upon combustion and increasing the yield of distillates. In 1985, experiments on a larger scale, in a 1000-gram coker, confirmed earlier experiments at a smaller scale.

Hydrotreating, the catalytic reaction of bitumen with hydrogen, is an alternative to coking. Its advantage is a greater yield of liquid product and little or no coke, which is already in abundant supply in Alberta. Research has been directed towards upgrading pitch, the solid byproduct of hydrotreating.

In the coking stage, as part of the process of converting bitumen to transportation fuel, one of the liquid products is coker gas-oil. This process requires expensive catalysts which are normally discarded once they become poisoned. Attempts are now directed towards the development of methods for regenerating these expensive catalysts. The results have been encouraging.

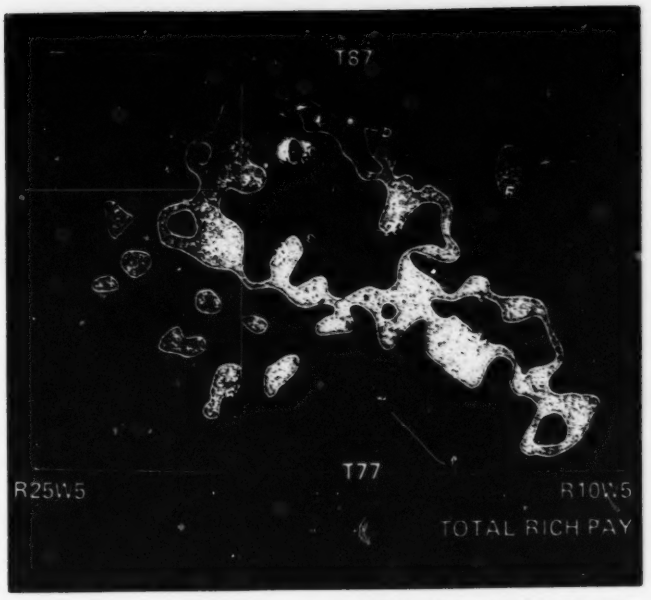
Asphaltenes are the ingredients in bitumen that hinder upgrading processes because of their metals content. Because of their sulfur dioxide content, they also render bitumen upgrading byproducts, such as coke or pitch, environmentally unsafe to burn. The Alberta Research Council has been conducting research on the removal of asphaltenes from bitumen prior to upgrading. Results of tests on the deasphalted bitumen, using the small coker (50 grams), have indicated the potential for producing 10 percent more liquid products during coking and half the amount of coke. The coke produced also appears to be suitable for electrode manufacturing.

An experimental coker is prepared for one of a variety of studies conducted during the year to address increased efficiencies in hydrocarbon upgrading.

Results of tests on the deasphalted bitumen, using the small coker, have indicated the potential for producing 10 percent more liquid products during coking and half the amount of coke.

In a project jointly developed with the Alberta Oil Sands Technology and Research Authority, the Alberta Research Council evaluated, in small autoclaves, the effect on distilled oil yield of adding low levels of coal to bitumen prior to hydrogenation. Results were sufficiently encouraging that work will continue in the program to evaluate this process in a larger continuous unit.

Using model compounds, preliminary fundamental studies on the chemistry of coal liquefaction and bitumen-coal coprocessing have shown that coal does not contribute in a major way to distillable liquid products. Coal can promote some increase in cracking



This map showing the distribution of rich oil sands in a 15 370 square kilometre region of the Peace River oil sands deposit is one of many providing public information on the distribution of the resource in Alberta.

In a joint program with the Alberta Oil Sands Technology and Research Authority, a series of studies was completed on oil sand deposits in the northern Cold Lake, Wabasca, Peace River, Athabasca, and Grosmont Carbonate Trend regions, and on the heavy oil belt in the Lloydminster area.

reaction, but can decrease desulfurization and hydrogenation activity of commercial catalysts. Clays typical of those associated with coal deposits have significant catalytic activity.

The Alberta Research Council developed the capability for evaluating catalysts for their effectiveness in bitumen upgrading and demonstrated that super acidic catalysts were more effective in cracking bitumen than existing commercial catalysts.

Previous research in catalysis has shown that certain soluble complexes containing two metal centres in close proximity are active as catalysts for reactions of hydrogen, or mixtures of hydrogen and carbon monoxide, with hydrocarbons. In the search for a means to maximize the yield of value-added products from these reactions, which include aldehydes and ketones, research has indicated that the precise distribution of the product depends on the solvent used and the temperature and pressure of the reaction.

A series of similar complexes has been made which contains two dissimilar metals with different catalytic properties: for example rhodium and platinum or rhodium and mercury. Although these new materials have not proven sufficiently rugged to be of commercial value, they have been valuable in increasing our understanding of the chemistry of the effective catalysts.

Work started in 1985 on preparing catalysts that are chemically similar to soluble catalysts, but are supported on insoluble inorganic oxides. Testing started on these materials as catalysts for reactions of syngas, a mixture of carbon monoxide and hydrogen derived from natural gas. The effectiveness of catalysts composed of more than one metal will be compared with the effectiveness of each metal alone on the same support.

Energy resources geology

The Alberta Research Council documents and evaluates the geology of regions in Alberta containing major oil sands and heavy oil resources. In a joint program with the Alberta Oil Sands Technology and Research Authority (AOSTRA), a series of studies was completed on oil sand deposits in the northern Cold Lake, Wabasca, Peace River, Athabasca, and Grosmont Carbonate Trend regions, and on the heavy oil belt in the Lloydminster area. Reports of these studies documented the geological framework and reservoir characteristics and include maps on the distribution of bitumen within each of the deposit areas. Results of these studies will be applied to various in situ thermal pilot projects in which AOSTRA is a partner.

Alberta Research Council geologists completed phase one of a project to map the regional stratigraphy of the Peace River arch area in northwestern Alberta. A synthesis of information on this area, with its proven and potential reserves of conventional oil and gas, is being compiled. This study will provide information to the public on the geology of this economically important area.

In evaluating the province's coal resources, the Alberta Research Council provides geological information and standards of interpretation for government and the coal industry. In a project jointly funded by Alberta Energy and Natural Resources and the Alberta Research Council, a coal resource inventory of the plains region to a depth of 400 metres was conducted. Using data from oil and gas wells and from wells drilled in the Alberta Research Council's coal exploration program, a study of southern Alberta was completed, enabling the provincial government to increase the understanding of the value of leases before they are assigned to companies. The data can also be used by coal companies to determine areas of the province that are suitable for exploration.

Data from this study are being used for computer generated maps illustrating depths of coal zones as well as amounts of coal in each zone. The inferred coal resources for the plains region, to a depth of 400 metres, were calculated to be 66 billion tonnes for the Horseshoe Canyon Formation, and 78 billion tonnes for the Ardley coal zone.

Contrary to the understanding that only lower rank, subbituminous coals are present in the plains

A field of winter wheat is grown from seeds of plants developed for winter hardiness at the Alberta Research Council through tissue culture techniques.

region, an Alberta Research Council report shows that higher rank, bituminous coals are also present at depths shallow enough to be mined.

In the foothills region, the Alberta Research Council completed computer models of the complex structure of the Grande Cache area. These models have been used to identify areas of thick coal accumulations.

Coal mining

A problem in surface coal mining is the collapse of high walls at points where the massive dragline shovels are located, resulting in a safety hazard and disruption of operations. In research on this highwall stability problem, an interdisciplinary research team focused on the Lake Wabamun area. With joint funding from TransAlta Utilities Corporation and the Alberta Research Council, researchers are determining the distribution and structure of glacially thrust bedrock and its contribution to highwall failures. Highwall failures are found to be of two major types: rotational slump along preexisting glacial shear planes; and block failure due to the thrust bedrock moving pitward along the basal glacial thrust plane. Recent research suggests that the thrust bedrock may be recognizable within a single lithological type, using downhole geophysical logs.

In a project jointly funded by the Office of Coal Research and Technology, of Alberta Energy and Natural Resources, and several coal companies, the project team is also helping evaluate the use of surface seismic techniques for the detection of glaciotectonic terrain.

Agriculture

Crop improvement

In a project to develop a line of wheat with enhanced winter hardiness, researchers have been using a tissue culture process, rather than conventional plant breeding procedures, to produce genetic variability for resistance to low temperatures. The researchers have two basic goals: develop the methodology of screening for low temperature tolerance of tissue cultures, and produce a large number of tissue cultures with the desired genetic variability and produce plants from those tissue cultures. During the year, researchers described an appropriate screening technique and, using seeds from 4000 wheat plants grown in a test field, started the actual screening process for low temperature tolerance.

In a project using similar techniques, researchers have been studying triticale, a hybrid combining the hardiness of rye in low temperature and drought conditions, with the kernel characteris tics and processing qualities of wheat. In the past, plant breeding techniques have not yielded a desired hybrid. Using tissue culture techniques, the Alberta Research Council has been attempting to develop a more desirable hybrid from the hardiest cultivars. Researchers have now succeeded in crossing the hardiest available cultivars of rye and wheat. Future work will require them to grow the new plants and recover the seeds to complete the screening process.

With the support of Alberta Agriculture, the Alberta Research Council has also been studying ways of developing alfalfa embryos for mass propagation. Because of cross-pollination in alfalfa seed production, a superior alfalfa genotype is impossible to maintain for further testing by sexual propagation. Also, asexual propagation by cuttings is a slow process. Using fermentation technology, researchers have been able to produce quickly thousands of embryos — each embryo potentially being an identical alfalfa plant. For instance, with the results of this research it would take only a month to produce 100 000 embryos (all potential plants with a uniform genetic background) in a one-litre fermentor, whereas conventional breeding methods would require at least two years and the use of a large greenhouse.

In another project involving alfalfa, the Alberta Research Council has been working in conjunction with

Temperatures are lowered under controlled conditions indoors to test experimental plants for winter hardiness.

Using fermentation technology, the Alberta Research Council has been studying ways of developing alfalfa embryos for mass propagation much faster than traditional plant breeding methods.

the University of Alberta and Agriculture Canada on methods to improve the quality of the crop. Researchers have been comparing the effectiveness of tissue culture techniques and conventional breeding methods. Agriculture Canada has been screening alfalfa plants for their cold hardiness, the University of Alberta has been screening plants for yield quality and disease resistance, and the Alberta Research Council has been producing plant embryos. During 1985, the plants from selected embryos were moved from the greenhouse into the field and were harvested. Next year will determine how many plants grown from the seeds of harvested crop survive.

Alfalfa sickness is a disease which, for Alberta, occurs in alfalfa every few years in the central part of the province. In screening alfalfa plants for resistance to the disease, researchers have also been comparing tissue culture techniques to conventional breeding techniques. Preliminary results have indicated that plant produced through tissue culture techniques were more capable of resisting the disease than those selected and grown from seed.

In a contract with BIO LOGICALS inc., of Toronto, and International Genetic Sciences Partnership, of Israel, the Alberta Research Council has been determining whether anthocyanins are effective as a natural food coloring to replace artificial food coloring. During 1985, using the tissue culture technique, researchers were able to produce pigments with anthocyanins. Future work will concentrate on scaling up this technology.

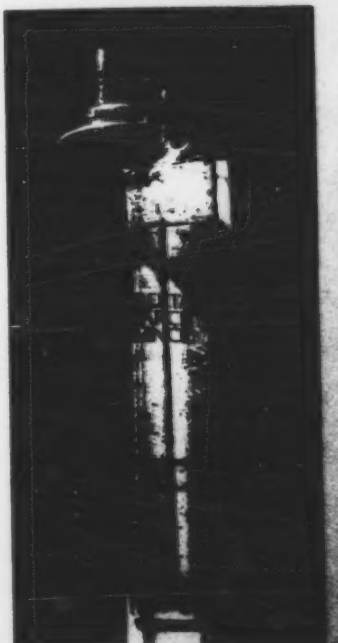
To complement the tissue culture research on cold hardiness of wheat and alfalfa, biochemistry is also being used. Researchers are studying which plant proteins bind to the plant hormone abscisic acid, which is responsible for the changes in metabolism of plants that make them tolerant to cold temperatures. In one project, a modified hormone was developed as an intermediate step in developing a hormone analog for use in these experiments; in another project, the conditions were developed for identifying which proteins had an affinity for the key plant hormone.

Soil and water

One of the Alberta Research Council's goals is to improve the level of understanding of the Alberta landscape so that improved land and water management practices and policies can be formulated. In a study to determine the rate and severity of soil erosion on selected landscapes in east-central Alberta, erodibility was estimated for all soils in the counties of Two Hills and Beaver. Based on this work, six study sites have been selected and instrumented for detailed observation.

The Alberta Research Council has also been conducting a hydrogeologic investigation of the causes of dryland soil salinity in southern Alberta, near the town of Carmangay. By comparing the distribution of regional groundwater flow to occurrences of dryland salinity, researchers have shown that regional groundwater flow does play an important role in soil salinization, because large areas of salinity correlate well with regions of upward-moving groundwater. Other data indicate, however, that seasonal surface water flows related to snowmelt and early- and late-summer precipitation also play an important role in soil salinization in this area.

In cooperation with Alberta Agriculture and Agriculture Canada, a land resources inventory of Flagstaff County has been initiated using a multidisciplinary team approach. The information generated by this project will contribute to the eventual completion



Rainfall is an important factor in research on the rate and severity of soil erosion in parts of the province.

of a uniform, intermediate-scale soils database for the province. A complementary research project to investigate questions related to the proper design, content, and quality control for land inventory has also been initiated.

In cooperation with the University of Alberta, the Alberta Research Council has developed a methodology for inventory of peatlands in Alberta. The methodology involves air photo interpretation and LANDSAT multi-spectral scanner data analysis.

Atmospheric sciences

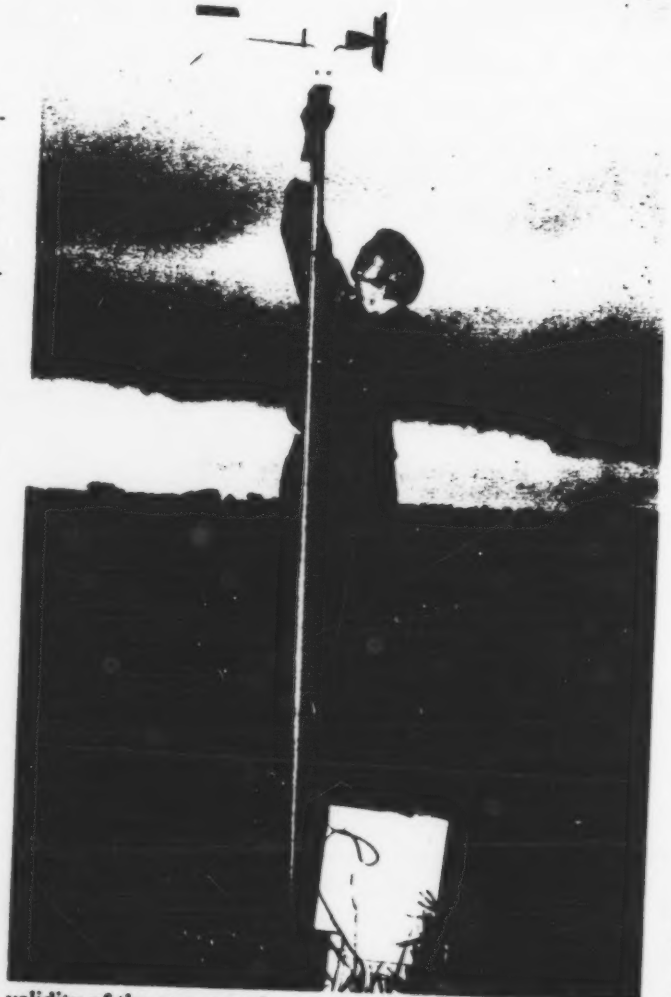
The Alberta Research Council is the central agency for weather modification research and operations in the province. Largely under the sponsorship of Alberta Agriculture, the current five-year mandate to develop weather management capabilities for hail suppression and rain and snow augmentation was completed.

Cloud seeding experiments were continued to monitor the initial development of rain and hail inside towering cumulus clouds, using a research aircraft developed by the Alberta Research Council and Intera Technologies Ltd. Whenever the cloud turrets merged with the main storm, however, the research aircraft could not safely fly into turbulent areas to monitor the growing precipitation interacting with the main updraft of the storm. To obtain more information about the growth of hail in the main part of the storm and to help confirm the seeding hypothesis, the Alberta Research Council contracted an armor-plated T-28 aircraft from the South Dakota School of Mines and Technology. The analysis of data from T-28 flights will form an important part of the final weather modification research report to the Alberta Government in 1986.

ROGER ROZELLE - AOPA PILOT MAGAZINE

An armor-plated aircraft, contracted for part of the summer from the South Dakota School of Mines and Technology, allowed researchers to penetrate the severest parts of hail storms to measure the effects of cloud seeding.

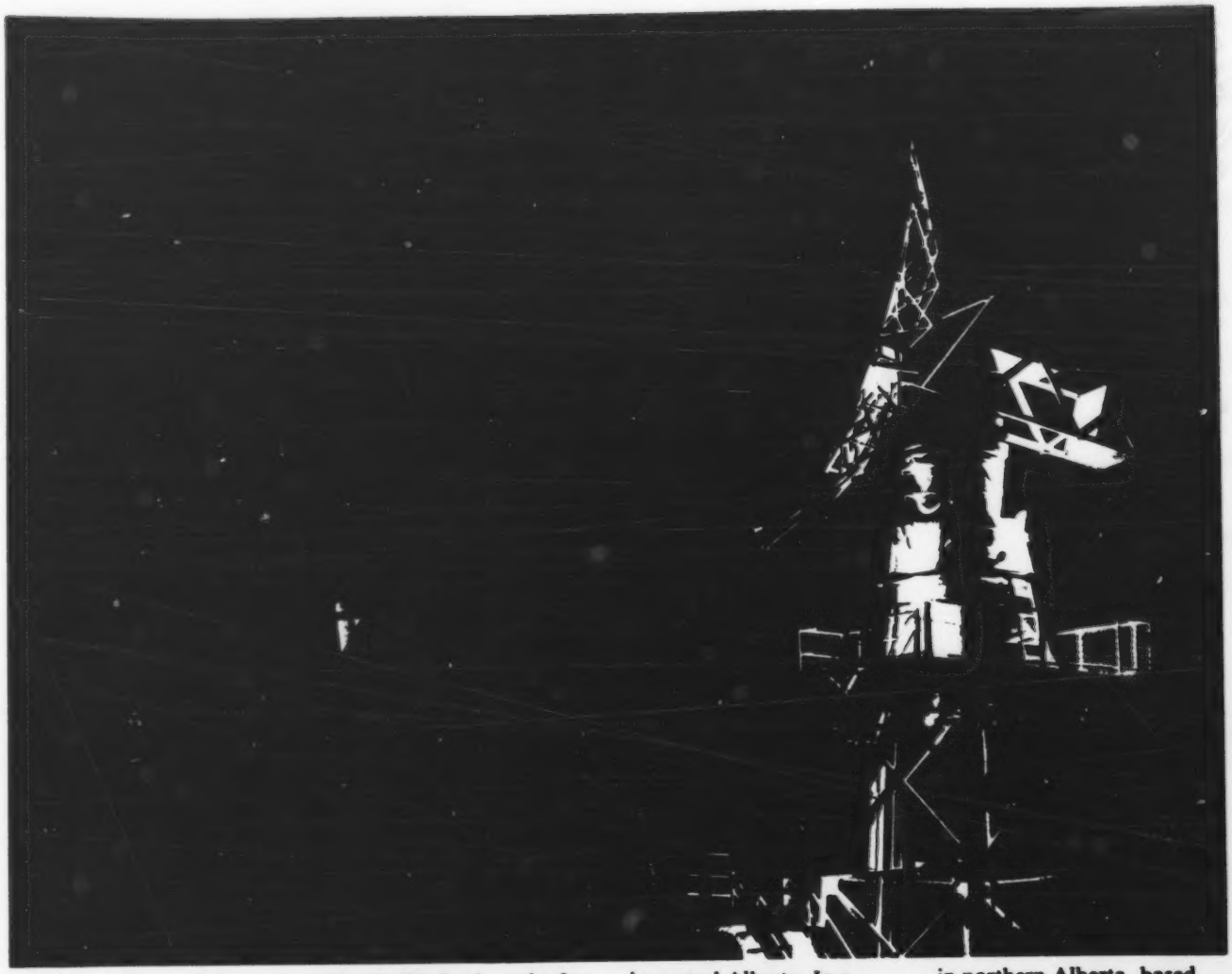
Cloud-top seeding experiments to increase rain continued to verify the differing effects of seeding with dry ice and silver iodide...



Wind speed is also a factor in soil erosion experiments which were conducted in six study sites in two counties.

Researchers tested the validity of the conceptual model of an Alberta hailstorm, which assumes that hail initially develops in the towering cumulus clouds associated with a hailstorm. Iron powder and indium flares were dropped into developing cloud turrets during tracer experiments, and hail samples were collected at the ground in the experimental region. Those hailstones containing the tracer material can be linked to a life cycle started in the cloud turrets.

Cloud-top seeding experiments to increase rain continued to verify the differing effects of seeding with dry ice and silver iodide and that, under certain conditions, seeding with dry ice or



Weather radars and an aircraft tracking radar have played a vital part in the weather modification research for Alberta Agriculture.

silver iodide leads to the formation of precipitation-size particles. Preliminary observations indicated that cloud base seeding also altered the ice crystal concentrations in cumulus clouds.

The Alberta Research Council is responsible for routine cloud seeding operations in the province and contracted Intera Technologies Ltd. to conduct seeding operations over a 25 000 square kilometre area in central Alberta. In a 10 000 square kilometre area of southern Alberta, I.P. Krick and Associates continued cloud seeding with ground based generators, a method being assessed by the Research Council.

In a contract with Alberta Energy and Natural Resources, the Alberta Research Council has been contributing its meteorological expertise to a computer model of barley yields in northern Alberta, based on various climate variables. Researchers developed a new statistical procedure for building the model. The study revealed that more than one moisture variable was needed, and that the moisture variables appeared to be more important than temperature variables in relation to crop yields. Energy variables were found to be of nonuniform importance.

Forestry and forest products

Forestry

Understanding the impact of forestry operations on the hydrologic and sediment regimes of forested areas is necessary to maximize timber yield and minimize the potential adverse effects of forestry operations on water resources. The Alberta Research Council has undertaken a project with the Alberta Forest Service to address many of the problems faced by forest managers in the design of harvesting plans. A method for determining soil erosion hazard was developed, linking a soil erosion model to standard soil survey information. The method will be useful not only to forest planners, but also to those concerned with terrain sensitivity in developing the province's resources.

Forest products

In conjunction with Alberta Energy and Natural

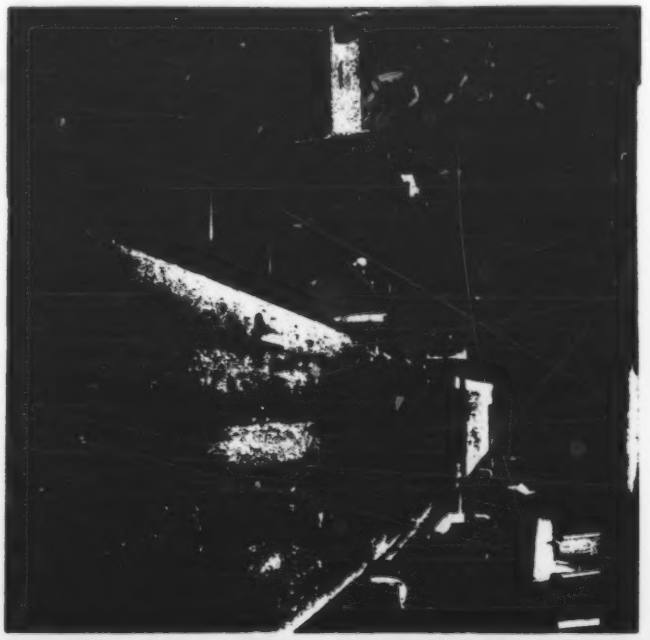
Resources, Alberta Economic Development and the Canadian Forestry Service, the Alberta Research Council conducted research and development, and provided testing services for the forest products industry in Alberta.

The Research Council has been developing a research capability for wood panel products and has acquired panel presses and associated equipment. Based on the static machine stress rating system previously developed with an engineering firm, the Alberta Research Council designed an online panel testing system for a typical forest products panel mill in cooperation with Columbia Engineering International Ltd., of Vancouver.

A former/orienter to make oriented strandboard, and a press platten system for developing corrugated panel products — technology which could greatly improve the strength-to-weight ratio of wood panel products — were constructed for the laboratory.

In cooperation with the University of Alberta, studies are being conducted on the mechanical behavior over time of panel products produced in Alberta. Knowledge from these studies will help increase the engineering uses of these products.

The Forest Products Testing Laboratory received its national accreditation by the Standards Council of Canada as a recognized forest products testing agency. Products such as plywood, oriented strand board, waferboard and specially designed beams were tested for performance and compliance with accepted standards. The Alberta Research Council also contributed to the Canadian Standards Association through committees that developed and published codes and standards for new products and for more efficient use of existing products.



Large wooden beams are one type of product tested in the Forest Products Testing Laboratory, which received accreditation from the Standards Council of Canada.

The Alberta Research Council has been participating in a national pavement impact study for CANROAD Inc.

Research is being conducted on a preservative for shingles that are exposed to Alberta's rigorous climatic conditions.

A research project in forest products has resulted in a corrugation process to improve the strength-to-weight ratio of wood panel products.

Transportation

A major concern of provincial road and highway management authorities is the damage to road surfaces by heavily loaded trucks. These authorities have been studying the practical balance between load levels and pavement life. The Alberta Research Council has been participating in a national pavement impact study for CANROAD Inc. The objective of the project, which is part of a larger national study of freight vehicle weights and dimensions, is to measure and analyze the effects of loads and axle spacings on sections of pavement selected as typical stretches of provincial highways.

Instrumentation for the study was designed, fabricated and installed by the ALberta Research Council at 13 locations throughout 6 provinces across Canada during 1984. The instrumentation is designed to measure critical internal strains and deflections in pavements under moving test loads. In 1985, the Alberta Research Council conducted a test at each site, using a specially built

The Alberta Research Council has been participating in a national pavement impact study and research in traffic engineering to contribute to more effective systems for designing, building and maintaining our roads and highways.

As a result of the Alberta Research Council's extensive experience and capabilities in the traffic engineering field, the Roads and Transportation Association of Canada contracted the Alberta Research Council for technical support in a national study.

multi-axle trailer designed to reproduce the wide range of axle loadings, spacings and combinations required for the test program. The instrumentation at each test site was linked to a computer on the Alberta Research Council's mobile data acquisition system vehicle.

Analysis of the data from the over 5000 dynamic load trials will show the relative road damaging effects of the various axle loads and configurations tested in relation to the widely varying heavy duty pavement structures provided by the provinces. With this information, motor transport administrators in the provinces will be in a better position to evaluate the economic impact of potential changes in provincial regulations required to achieve a more uniform national standard.

In another project related to pavement impact, the Alberta Research Council has been working with the National Research Council in studying the dynamic characteristics of selected axle suspension systems and resulting pavement response. A specially designed test vehicle was combined with pavement reaction instruments to conduct field tests in Quebec. Analysis of the results is underway.

As a result of the Alberta Research Council's extensive experience and capabilities in the traffic engineering field, the Roads and Transportation Association of Canada contracted the Alberta Research Council for technical support in a national study. The technical support was the development of specifications for the Computerized Data Acquisition System, providing customized software for data processing, training field personnel in data acquisition techniques and providing assistance in data analysis.

The pavement management system database was updated and a similar datafile was created for the provincial secondary road network in Alberta. This work is part of a long-term joint research project with Alberta Transportation. Using new data in the files on Alberta's primary highways, a project was started to re-evaluate the computer models for predicting pavement performance. These mathematical models are essential to the Alberta Pavement Management System in forecasting maintenance needs of the province's highways.

A major component of the pavement performance prediction system is the identification and measurement by Alberta Transportation of defects in pavement surfaces. This procedure of visual assessment by department officials was reviewed in detail and a modified version is proposed for incorporation in the pavement management system.

Ice on road surfaces resulting from blocked culverts is a winter driving hazard in some parts of Alberta. Since thawing the ice with steam or electrical heating cables would prove too costly at remote sites, Alberta Transportation has contracted the Alberta Research Council to test a solar energy system for thawing the ice. Researchers designed a closed loop pipe now installed at a test site on Highway 11 near Banff National Park. Solar energy is applied to heat the fluid in the pipe and also act as a power source for pumping the fluid. Monitoring of the system to evaluate perfor-

mance and cost-effectiveness has started.

The accurate estimation of water discharge and associated water levels is important in the design of bridges or culverts on streams draining small watersheds. Many areas of the province have few, if any, streamflow records on which to base the selection of an appropriate design flow. A 10-year program of data collection and analysis on over 40 small watersheds in central Alberta was completed this year. The project provided flood frequency analysis and an assessment of hydraulic performance of structures that will aid engineers and planners in selecting design discharges. Efforts are now directed at extending this analysis to all the major drainage basins in the province to provide design criteria for peak discharge based on readily available geographic data.

Environment

Canal liners

Alberta Environment has been lining irrigation canals in the southern part of the province with plastic to prevent water from seeping out of the canals and carrying dissolved salts to the surface of adjacent land. The Alberta Research Council has been conducting research on the physical properties of geomembranes used as liners, to improve their handling characteristics at sub-ambient temperatures as low as -30°C. An extensive database of test results for these polyvinyl chloride geomembranes has been developed as a result of this research work. The database will prove useful in future evaluations of the long-term performance of canal liners.

Land reclamation

The Plains Hydrology and Reclamation Project, a multi-disciplinary and cooperative study by government and industry and funded by the Alberta Heritage Trust Fund, completed its seventh year. Researchers have been developing techniques for replacing mined overburden and designing landscapes to minimize soil salinization in land reclaimed following surface mining. Initially, reclaimed soils appear to have a capability for agriculture similar to soils prior to mining. In some places, however, this initial capability declines as salt moves upward from shallow water tables. Another process contributing to salinization in flat, reclaimed terrain is upward migration of salts from the ponding of surface water in shallow depressions that result from surface subsidence.

Continued research at the Smoky River Coal Ltd. operations near Grande Cache has indicated that good soil management and the selection of appropriate plant species will result, over time, in diverse plant communities.

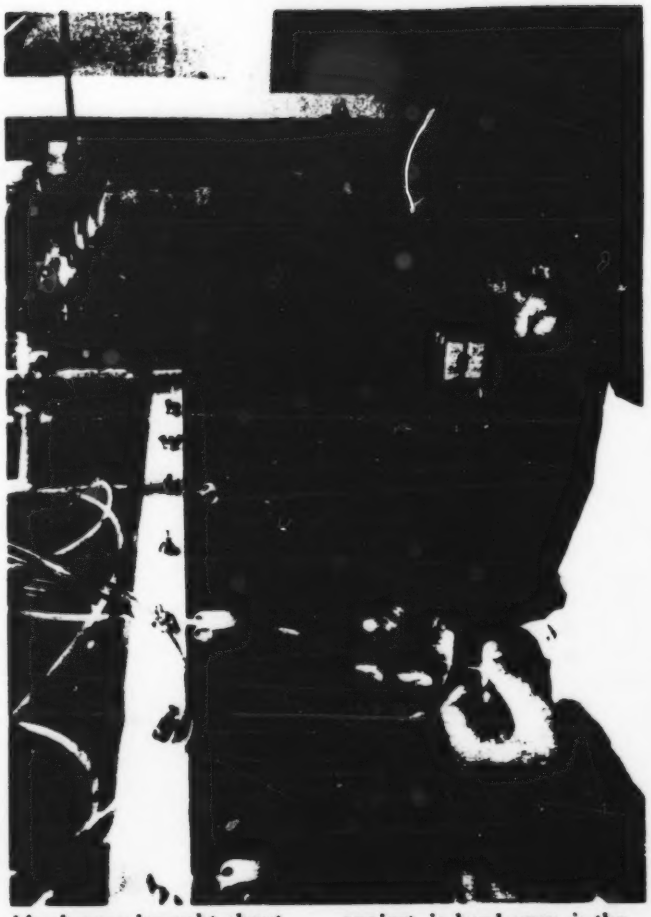
Ice on road surfaces resulting from blocked culverts is a winter driving hazard in some parts of Alberta. Alberta Transportation has contracted the Alberta Research Council to test solar energy to power a system for thawing the ice.

Part of a major, three-year study completed on the current hydrogeology of the Cold Lake area included the development of a database which should prove useful for similar studies in the future.

Water and earth resources

The Alberta Research Council, with equal funding from Alberta Environment, completed a three-year study of the Cold Lake area to determine the regional hydrogeologic conditions. The study defines the basic hydrogeology prior to possi-

The Soils Analytical Laboratory is an essential part of the survey and research work of terrain scientists.



In a contract for Suncor Ltd., the Alberta Research Council has been studying the feasibility of spreading a high lime content sludge on land. The sludge is a byproduct of the water treatment process at Suncor's Fort Kent heavy oil plant.

ble changes brought about by commercial in situ oil sands recovery operations and deep waste disposal. The results of the study were presented in three distinct formats.

The first format is a six-volume report on the regional geology of the entire sedimentary sequence, the hydrology of surface waters over a representative area, and the hydrogeology and chemistry of formation waters. It also includes the application of a numerical model for simulating the natural, steady-state flow of groundwater in a selected part of the sedimentary bedrock sequence. The methodology and techniques to handle, interpret and synthesize the large amounts of information, including the database, database management and data processing, are also presented.

The second format is an atlas of 220 maps and cross-sections at a scale of 1:500 000. The ground water database developed for the project, in hard copy, is the third format. It includes new and interpreted information on the hydrogeology, also available in a format accessible by computer. This study not only provides information to government and industry in Alberta, but also has developed valuable software for future hydrogeology studies.

The Alberta Research Council completed a study with the Alberta Special Waste Management Corporation on the possible effects of deep waste injection at the province's first special waste management facility, near Swan Hills. This project, based on the methodology developed previously in the Cold Lake project (described above), is similar in magnitude and format, except that only the hydrogeology of bedrock strata was studied. The effects of injection in selected aquifers were assessed using numerical simulation, and the preferred injection aquifer was identified.

In a contract for Suncor Ltd., the Alberta Research Council has been studying the feasibility of spreading a high lime content sludge on land. The sludge is a by-product of the water treatment process at Suncor's Fort Kent heavy oil plant. Preliminary results are promising. Applied at reasonable rates, the sludge appears to have no negative effects on plant growth and may prove to be an alternative to adding lime to acidic agricultural soils.

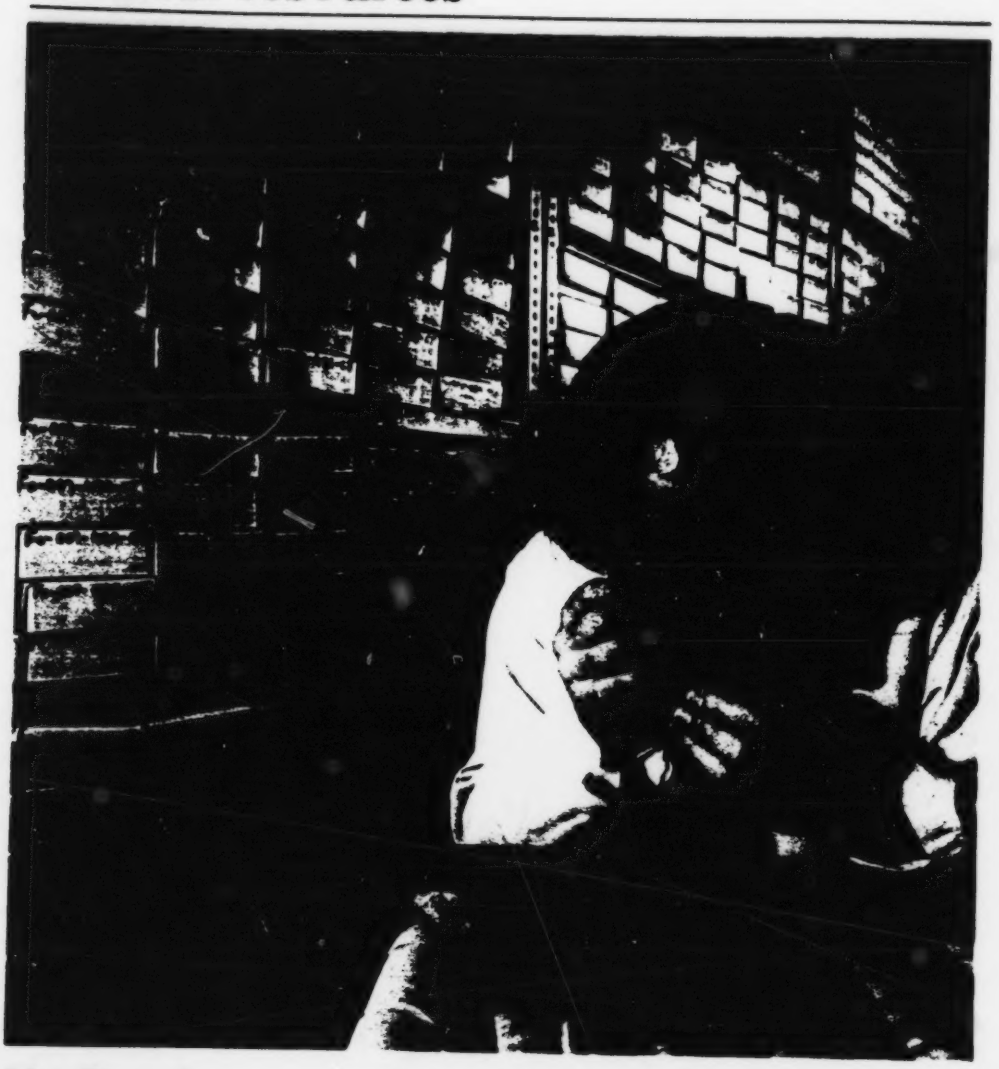
On behalf of Alberta Environment, the Alberta Research Council completed a literature study on the methods most commonly used to analyze soils for cadmium, copper, lead, nickel and zinc. The analytical procedures were discussed in the context of the chemistry of these heavy metals in soil and the environmental significance of the analytical results.

As part of the acid deposition research program, the Alberta Research Council conducted a literature review on the impact of acid deposition on soils, with particular emphasis on relating world literature to the soils of Alberta. In a related project, researchers prepared, for Alberta Environment, maps of the province showing the distribution of soils sensitive to acid deposition and their potential for neutralizing acid deposition.

Air quality

The Alberta Research Council completed a three-year contract for Alberta Environment to study the atmospheric transport and diffusion of smokestack effluent from oil sands processing plants in northeastern Alberta. Observations at the source and in the effluent plumes downwind from these plants have provided measurements to determine the conversion rates of sulfur dioxide and nitrous oxide gases in the atmosphere. In some cases, the plume was detected at distances up to 50 kilometres from the stack.

Natural resources



The first part of a study on potential uranium deposits in the Athabasca Basin was completed using geologic data at the mineral core research facility.

Under contract to Alberta Energy and Natural Resources, the Alberta Research Council has been preparing a catalogue of information on metallic and industrial minerals in the province.

Metallic and industrial minerals

Under contract to Alberta Energy and Natural Resources, the Alberta Research Council has been preparing a catalogue of information on metallic and industrial minerals in the province. The project has consisted of gathering existing information on mineral resources, assessing and classifying the level of information, and identifying gaps. Researchers are continuing this project with research and survey work to fill gaps in the information where a need is indicated.

Phase one of this project, completed in 1985, includes an atlas of 45 maps with 2000 references on 21 mineral commodities, a project overview report and technical profile reports on four specific commodities: limestone; sodium sulfate; lead-zinc; and gold. As well as indicating where needs exist for more information on these commodities, the project documents the potential for mineral resource development in Alberta.

Another project involves the collection and automation of data on the metallic and industrial mineral deposits in the province.

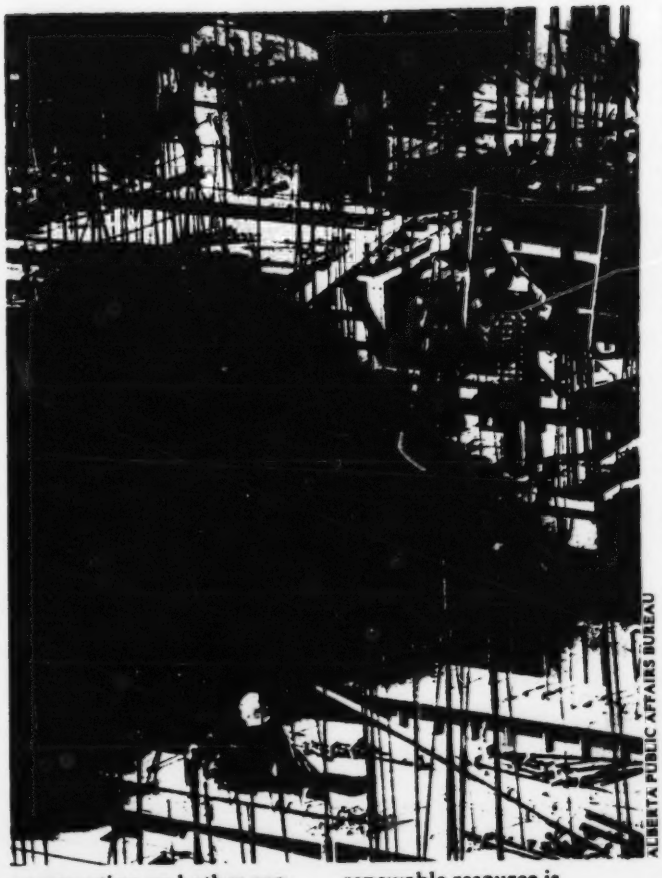
It is part of the Alberta Research Council's contribution to a natural resources information system for the province. Alberta Energy and Natural Resources will be integrating the information from other sources to establish priorities for development.

The first part of a study on potential uranium deposits in the Athabasca Basin was completed. Based on geologic data filed at the Alberta Research Council's mineral core research facility, the work was performed under contract to Alberta Energy and Natural Resources. It concludes that over 75 percent of the basin contains potentially exploitable uranium within 600 metres of the surface.

Aggregate resources

A major study by the Alberta Research Council indicated that the Edmonton/Lloydminster region uses over 12 million cubic metres of sand and gravel annually, mainly for road

The construction industry depends on aggregate resources in the province. A major study on the supply and use of sand and gravel in the Edmonton/Lloydminster region was released during the year.



ALBERTA PUBLIC AFFAIRS BUREAU

Researchers have been mapping the location and nature of aggregate deposits in three areas of the province: Bistcho Lake-Hay River; north of Lesser Slave Lake; and north of Fort McMurray.

construction and other provincial and municipal government projects. The supply of this essential, non-renewable resource is dwindling. To assist provincial and municipal planners, land managers and the aggregate resources industry, Research Council staff completed a major bulletin on how fast the resource is depleting, when it will run out and what can be done to use the resource more efficiently.

Under contract to Alberta Energy and Natural Resources, researchers have been mapping the location and nature of aggregate deposits in three areas of the province: Bistcho Lake-Hay River; north of Lesser Slave Lake; and north of Fort McMurray. The fieldwork and lab analysis for these reconnaissance level maps have been completed.

The Alberta Research Council is preparing to contribute information to a database on natural resources in the province, being developed by Alberta Energy and Natural Resources. Researchers completed an initial phase of this contribution to the database, the Natural Resources Information System, by developing a computer storage format compatible with the central database.

Industrial assistance

Industrial development

The Alberta Research Council solves short term industrial problems, supplies technical assistance and information, and puts Alberta's small industrial entrepreneurs in contact with those parts of the Alberta Research Council or other agencies across Canada most able to assist them. It also promotes and administers the National Research Council's Industrial Research Assistance Program (IRAP) in the province.

In 1985, the IRAP funding in Alberta remained at previous levels, but the amount of funding allocated to each client was reduced by the National Research Council so that more clients could be served. The IRAP-H program, which provides salary support to companies interested in hiring science and engineering students to help solve short-term technical problems, resulted in the hiring of 72 students, as compared to 48 the previous year. Under the IRAP-L program, small-and medium-sized companies are eligible for financial assistance in solving technical problems or fulfilling testing requirements by contracting the work to appropriate laboratories, institutes or consultants. The IRAP-L projects increased to 125 from 114 a year earlier. The 32 IRAP-M grants provided salary support to companies for technical personnel engaged in short-term scientific or technical research projects. The 10 IRAP-P grants provided financial assistance to companies involved in long-term applied research projects of high technical merit.

The research engineering staff responded to 5400 client contacts (including IRAP projects) and their industrial assistance covered many types of activities and problems. The following are selected examples.

Fiodrain Ltd., of Edmonton, manufactures "Fiovalve", an automatic counterbalanced check valve to be used on the main waste water lines leaving a building. The Alberta Research Council reviewed patents on similar products and listed patent claims on the "Fiovalve," which helped the company apply for patents in the United States and Canada. Com-

Fiodrain Ltd., of Edmonton, has received technical advice on design and materials and assistance with patent applications and marketing for these basement flooding and sewage back-up control devices now in production.

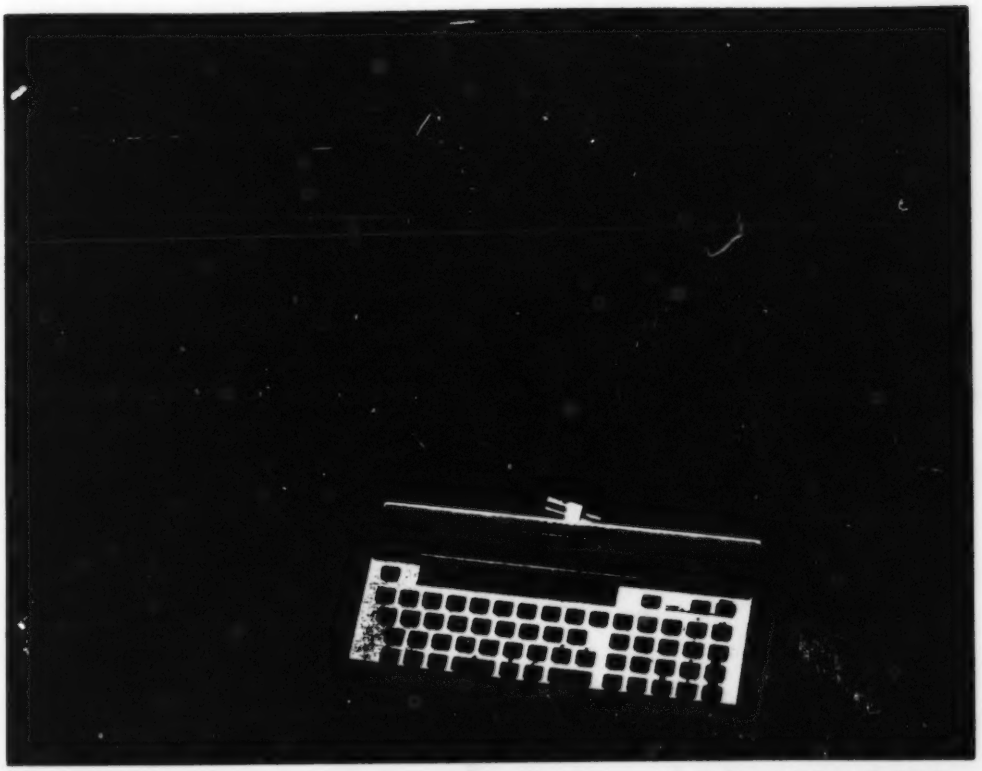
struction materials and design parameters were reviewed with the company. The Research Council also arranged for chemical resistance of the plastics to fulfill requirements for Canadian Standards Association approval. Marketing methods were also discussed with the company. The Fiovalve is now in production.

Global Thermoelectric Power Systems Ltd., of Bassano, manufactures remote power thermoelectric generators, oilfield drilling instrumentation and compressor control systems. To diversify its product line, Global Thermoelectric developed Compucab, a compact, computerized taximeter. The limited production prototype showed several aesthetic deficiencies which would hamper marketing efforts. Global Thermoelectric approached the Alberta Research Council for assistance. Under two IRAP-L grants, the company contracted an industrial designer to redesign Compucab. Three Calgary taxi companies are now using the compact, aesthetically pleasing taximeter and it is currently marketed through 30 dealers in 8 provinces across Canada and in 16 of the United States.

With IRAP support, a company in Bassano was able to complete development of a compact taximeter which it is now marketing in Canada and the United States.

Toffait Manufacturing, of Calgary, is a manufacturer and retailer of speciality ice cream and frozen dessert products. The company approached the Alberta Research Council for financial support under IRAP to develop a non-dairy, soy-based frozen dessert. Under an IRAP-H grant, and with the cooperation of Alberta Agriculture's Food Processing Development Centre, a project was established to develop and formulate a commercially acceptable frozen dessert product. Various prototype formulations were developed and tested through consumer evaluations, resulting in the introduction of three, flavored soy-based products into the Alberta marketplace. Consumer market response has also been

A Calgary manufacturer was assisted by an IRAP-H grant in developing a non-dairy, soy-based frozen dessert.



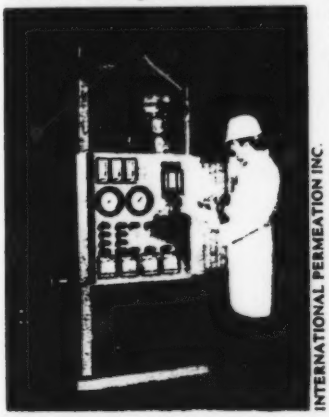
Hardware and software problems in development a self-contained data recorder for fieldwork were overcome with IRAP assistance.

An IRAP-M grant has permitted the development of unique, low-power sensors compatible with Lakewood's power-saving data recorder. Lakewood Systems Limited is now marketing its product in North America and southeast Asia.

positive in eastern Canada and has led to increased production.

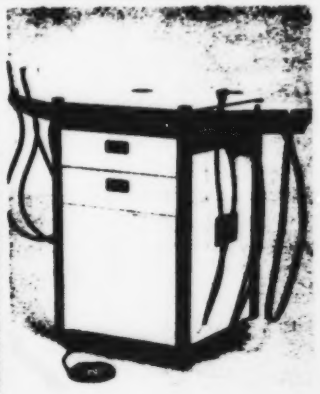
Lakewood Systems Limited, of Edmonton, provides services in design and implementation of various hardware and software systems associated with sewage and drainage, treatment plants and environmental monitoring stations. Lakewood had developed a data recorder which operates under its own power and eliminates paper or tape data recorders in the field. Lakewood recognized the potential of this technology for other clients. To develop a more universal, advanced data processing device for recording temperature, pressure and flows in extreme environmental conditions, Lakewood encountered several hardware and software problems. Through an IRAP-H grant, a student worked on enhancing the software package for a remote terminal. Under IRAP-L grants, Lakewood hired a consultant to research and develop specific computer software programs for providing graphs and tables of data directly from portable recording computers, and to develop hardware and software for communicating the data. An IRAP-M grant has permitted the development of unique, low-power sensors compatible with Lakewood's power-saving data recorder. Lakewood Systems Limited is now marketing its product in North America and southeast Asia.

Actiplast Industries Ltd., of Calgary, manufactures custom fiberglass and fiberglass-reinforced plastic (FRP) products. Company activity had been severely hampered by the recession in the oil and gas industry. Actiplast had an opportunity to bid on FRP furniture for the Grande Cache Correctional Institute, but lacked the in-house engineering and design capability to meet requirements identified by the provincial government. A time limit of three months for preparing the bid placed considerable pressure on Ac-



INTERNATIONAL PERMEATION INC.

This prototype of a gas separation processing unit is based on technology developed at the Alberta Research Council and now being commercialized by an Alberta company.



A manufacturer of self-contained, modular dental units also received IRAP funding under the National Research Council's Industrial Research Assistance Program (IRAP).

tiplast to take action. Under an IRAP-L grant, RPC Engineering Ltd., of Lacombe, designed and developed FRP furniture to comply with provincial government standards. Actiplast not only bid on, but won, the Correctional Institute contract. The contract also resulted in the firm's establishing a new product line.

Power

The Alberta Research Council has a contract with the Canadian Electrical Association for developing methods to forecast damaging lightning flashes using radar observations. To date the study has found the frequency of power outages is directly proportional to various lightning parameters. The radar echoes from storms which produce lightning can be used to estimate damage potential. A computer program has been developed to forecast at least 30 minutes in advance, and at 15 minute intervals, the location of a damaging lightning core and the probability of resulting damage for any storm observed by the radar.

Processing, upgrading and pipelining

The Alberta Research Council has the expertise and facilities to perform research and a wide variety of physical and chemical tests on materials and products to help Alberta manufacturers with technical problems and product development.

An excellent example of how technology can be developed and transferred to industry for commercial production is the membrane technology for separation of industrial gases. Alberta Helium Limited, of which the Alberta Research Council has been a partner, commercially developed the technology with support from the Alberta/Canada Energy Resources Research Fund. During 1985 this firm reorganized from its research orientation to become International Permeation Inc (IPI), reflecting the firm's commercial interests and greater size with the addition of new partners. IPI conducted pilot-scale field demonstration tests of the membrane process for separating carbon dioxide, hydrogen sulfide and hydrogen from complex gaseous mixtures.

A fine, hollow fiber forming the permeation membrane for separating gas mixtures, is compared to a common thread.

An excellent example of how technology can be developed and transferred to industry for commercial production is the membrane technology for separation of industrial gases.

In developing more cost-effective modules for commercial demonstration of the membrane process, an automated drying method was developed for converting membrane modules used in water purification to gas separation permeators. Other technical support included feasibility studies, laboratory simulation tests, process design and optimization, and analysis of pilot plant test results.

Continuing work on the technical feasibility of transporting heavy oil as oil-in-water emulsions, a study of an emulsion using Cold Lake crude oil was completed. In response to a demand from the heavy oil production industry, experimental work in this area has expanded to include non-emulsified heavy-oil brine systems.

The Alberta Research Council assisted an Alberta company in developing a process for extracting, with oil, fine-grained columbotantalite minerals from complex ores. This process appears to have significant advantages over conventional beneficiation techniques in the recovery of other fine-grained minerals which have a particle size less than 20 microns.

Analysis and testing

Fire protection devices designed to shield process equipment in the event of a hydrocarbon-fueled fire were tested. The test was to evaluate, on behalf of the manufacturer, the capability of the devices to withstand temperatures in excess of 1000 °C for a period of 20 minutes or more to permit shutting down process equipment in the event of a

Among the various testing and inspection services provided by the Gasoline and Oil Testing Laboratory is the performance testing of gasoline, diesel and cetane fuels in test engines.

Fire protection devices designed to shield process equipment in the event of a hydrocarbon-fueled fire were tested.

fire. Among other material evaluations performed for Alberta companies to assist with product development or product evaluation, a test rig was constructed and operated to evaluate the performance of capsules used in pneumatic radiography cameras.

The Industrial Services Laboratory performed environmental surveys for the fertilizer industry and chemical testing projects for both large and small companies. Most of the projects were nonroutine, involving identification and formulation as well as quality assurance. Ten projects were for companies which had difficulty in getting the work done elsewhere.

The Gasoline and Oil Testing Laboratory provided clients with a wide range of testing and inspection services on refined petroleum products when the analytical capability was not otherwise available through other laboratories. Clients have included federal authorities, such as National Defence Canada and the Royal Canadian Mounted Police, provincial government departments, such as Alberta Agriculture, Alberta Consumer and Corporate Affairs and Alberta Attorney General, various Alberta municipalities, and several private companies. The laboratory also administered, on a contract basis, three petroleum exchange programs under the auspices of the Petroleum Coordinating Committee of the Canadian General Standards Board, and a similar program under the auspices of the American Society for Testing Materials. The exchange programs are recognized as essential for quality control and assuring the consumer of the highest standard of laboratory service. This laboratory also continued to be active in the work of the Canadian General Standards Board Petroleum Coordinating Committee and its associated committees.

The Oil Sands Analytical Laboratory provided analytical support to the Oil Sands Research Program and other research programs as well as to government departments and industry. Researchers constructed an instrument to measure asphaltene flocculation and precipitation in solutions of bitumen and heavy oil. They studied the effects of additives on the flocculation of asphaltenes and found that certain additives can reduce the precipitation of asphaltenes. Methods were developed to study the composition of bitumen and related materials to give a rapid characterization of the heavy petroleum materials. Also, a procedure was developed in the laboratory for quality control of chemicals used by an oil well servicing company.

The Chemistry Analytical Laboratory provided analysis for projects throughout the Alberta Research Council and for outside clients, using specialized instruments such as atomic absorption, inductively coupled plasma spectrometry, x-ray florescence, nuclear magnetic resonance, infrared spectrometry and gas chromatography/mass spectrometry. Outside clinets included the Department of National Defence, Environment Canada, the Provincial Museum of Alberta, the University of Alberta and various private companies. The laboratory's capability in flow injection analysis expanded during the year with the addition of methods for glucose, protein and ammonium. The laboratory also developed gas chromatographic/mass spectroscopic methods for identifying chemicals derived from plants including flavonoid compounds.

In the area of plastics testing, the Alberta Research Council provided services to Alberta Environment, Alberta Public Works Supply and Services, private consultants and geomembrane producers. The industrial use of geomembranes and geotextiles is a relatively new industry for which performance standards are currently being developed. The Alberta Research Council is a member of the Canadian General Standards Board subcommittee on geomembranes and geotextiles.

The Geological Survey's Analytical Laboratories supported geological studies by preparation of 249 thin-sections of rock samples, 89 size analyses of unconsolidated material, 810 mineral identifications by x-ray diffraction analysis and 292 other sample preparations. This support was for projects in oil sands, mineral resources, and sedimentary geology.

The Soils Analytical Laboratory is operated jointly by the Alberta Research Council and Agriculture Canada to provide analytical support for soil survey and terrain sciences research projects. The laboratory provided 37 000 analyses on 3100 soil samples in support of terrain sciences studies during the year.

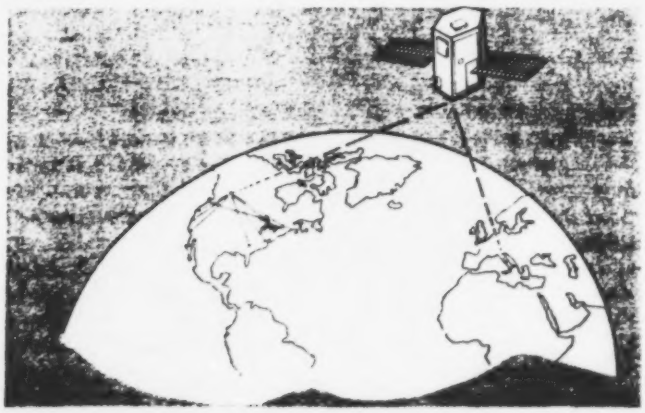
The Chemistry Analytical Laboratory provided analytical services to private companies as well as the provincial and federal governments with specialized instruments such as gas chromatography/mass spectrometry.

Information centres

The Alberta Research Council operates six information centres to provide information for industry, government, the general public and staff.

Managed by the Alberta Research Council, the Alberta Oil Sands Information Centre is funded by the Alberta Oil Sands Technology and Research Authority (AOSTRA). It is a central source of all published information on oil sands, enhanced recovery processes and heavy oils. In 1985, it responded to approximately 3700 enquiries in these areas, compared with 3000 the previous year. QL Systems and

The Alberta Oil Sands Information Centre responded to approximately 3700 enquiries compared with 3000 the previous year. QL Systems and CAN/OLE, based in Ottawa, and SPIRES, at the University of Alberta, provide online access to the bibliographic databases.



The Industrial Information Centre, with offices in Calgary and Edmonton, provided clients with access to more than 600 databases on 11 computer systems in Canada, the United States and Europe.

The Coal Technology Information Centre, in Devon, increased the number of entries on its Coal-Abs database to 21 000.

To assist the growing electronics and telecommunications companies operating in the province, the Alberta Government established, under the auspices of the Alberta Research Council, the Electronics Products Information Centre.

CAN/OLE, based in Ottawa, and SPIRES, at the University of Alberta, provide online access to the bibliographic databases. The centre also maintains a numerical database on international information about physical properties of oil sands, in conjunction with the Alberta Research Council's Oil Sands Sample Bank. A bi-monthly newsletter, the *Tar Paper,* was distributed to over 1800 subscribers in 34 countries.

The Coal Technology Information Centre is funded by the Alberta/Canada Energy Resources Research Fund and managed by the Alberta Research Council. It provides information on mining technology, coal beneficiation, coal conversion (liquefaction and gasification), combustion, environmental aspects and energy policy. The Coal-Abs database increased by 4000 entries to a total of 21 000. In order to make this information accessible to people working in the area of coal, the information staff produces the *Current Acquisitions Bulletin,* a semimonthly update of new material added to the database. Coal-Abs is also available online through SPIRES at the University of Alberta. The centre responded to enquiries from researchers, industry, the educational sector and the general public.

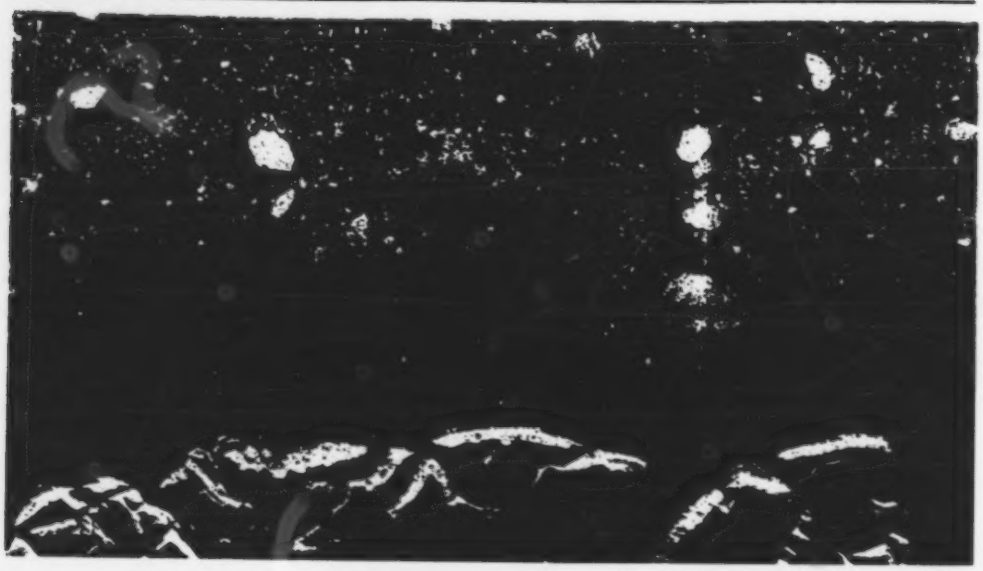
The SWERP (Solar and Wind Energy Research Program) Information Centre stopped operating at the end of 1985. Funded by the Alberta/Canada Energy Resources Research Fund and operated on a contract basis by the Alberta Research Council, the Centre had a mandate to collect and disseminate scientific and technical information on solar and wind energy and related technologies. During 1985 there were 1086 requests for information from the general public, governments, industry and commercial sectors, education institutions and other libraries and information centres. In June, the centre concluded its contract with the Canada Institute for Scientific and Technical Information (CISTI) for the joint development of the Canadian energy database, ENERCAN. The extensive collection of solar and wind energy documents has been transferred to the University of Alberta Science and Technology Library, ensuring the collection's continued availability to the public. This collection also forms the basis for the SWERP database, a public subfile available on magnetic tape through SPIRES at the University of Alberta Computing Services.

The Industrial Information Centre interacts mainly with manufacturers and scientific/engineering companies. Clients in Alberta have access, through offices in Calgary and Edmonton, to 95 percent of the world's published scientific and technical literature in the more than 800 databases of 13 computer systems in Canada, the United States and Europe. This service was provided to people from industry and government as well as the Alberta Research Council and the National Research Council. Over 3000 enquiries resulted in 12 000 bibliographic searches. As a result of these searches, about 5000 documents were processed.

Information Geology has undergone continued growth in both the use of its bibliographic geoscience database, GEODIAL, and the handling of geologic enquiries. GEODIAL contains over 6,000 records and was used to produce a catalog of reports on Alberta's industrial and metallic minerals for Alberta Energy and Natural Resources. Also a data transfer system was established between GEODIAL and a national database, GEOSCAN, maintained by the Geological Survey of Canada in Ottawa.

To assist the growing electronics and telecommunications companies operating in the province, the Alberta Government established, under the auspices of the Alberta Research Council, the Electronics Products Information Centre to provide technical and marketing data for the industry. Through a $1.5 million grant, for 3 years, the information service is to provide online services to national and international databases. In addition, the information centre plans to test and evaluate a new interactive teleconferencing system currently under development by an Alberta company.

New technologies



A joint research venture is applied to the data processing system for generating images of ice packs in northern waters by synthetic aperture radar onboard an aircraft.

The Alberta Research Council has been working on an artificial intelligence project, called METEOR, to incorporate numerical models and other forecasting tools into knowledge-based systems to produce intelligent consultants and assistants for forecasting.

Computing and automation technologies

Meteorologists, particularly forecasters, require extensive training to be able to interpret the large amount of data generated by radars, satellites and related computing systems. An experienced forecaster has the ability to combine meteorological theory with local knowledge acquired over the years to interpret weather conditions and produce forecasts. Current numerical models and traditional computing systems cannot easily represent and manipulate this kind of knowledge and information. The Alberta Research Council has been working on an artificial intelligence project, called METEOR, to incorporate numerical models and other forecasting tools into knowledge-based systems to produce intelligent consultants and assistants for forecasting. METEOR has been developed as a prototype system for forecasting the location, movement and intensity of convective storms for the Alberta Research Council's work in weather modification. During a field test in August, METEOR successfully forecast the existence and intensity of what turned into the most severe storm of the summer.

A typical summer storm over Alberta could, in the future, be forecast and described in its intensity by METEOR, an artificial intelligence project being developed for weather forecasting.

A research and development program in information and automation technologies, launched in 1984, continued to develop rapidly. The program was established to allow the Alberta Research Council to help companies in the energy, manufacturing, agricultural and service sectors, as well as emerging advanced technologies firms to become more competitive by providing research and development in information and automation technologies. The program has also been assisting industry through

A joint research venture with a Calgary firm is developing the system for digitizing maps relatively quickly and inexpensively.

In cooperation with the University of Victoria, the Alberta Research Council is conducting expert systems research into the medical diagnosis of liver malfunctions.

technical collaboration, contracts and joint research ventures. Advanced computer systems, graphics capabilities and robotic manipulator systems are being added to the program so that the Alberta Research Council can demonstrate the advantages of such systems to Alberta companies for their own development.

Research on information technologies falls into the two categories of expert systems and participant systems. Expert systems enable human expertise to be encoded in computers so that the computers can become valuable assistants. The quality of products and the productivity of companies can increase by having a computer distribute human expertise throughout the operation with expert systems technology. Expert systems apply to four classes of activity: design; interpretation; modelling of continuous processes; and detection of faults. In cooperation with the University of Victoria, the Alberta Research Council is conducting expert systems research into the medical diagnosis of liver malfunctions. In a joint research venture with D&S Petroleum Consultants Ltd., of Calgary, expert systems research is also being applied to well-log analysis.

Participant systems are computer systems which allow people or expert systems in various locations to work together on shared complex tasks. Research has started in this area.

The Alberta Research Council has also started projects in automation technologies, in the area of robotics. Opportunities for robotics research exist in oil well drilling and in the use of underwater manipulator systems for offshore exploration. Also, robotics technologies are central to flexible manufacturing systems (FMS), which are particularly suited to Alberta industries because they facilitate production in small batches. With automated tools, small manufacturers can respond to market demands more quickly than large volume manufacturers, dramatically changing economies of scale.

In design automation, the Alberta Research Council has been working with Alberta companies on a research project to provide industry with computer aided engineering, testing and simulation techniques, human factors engineering, and industrial design. These design automation technologies are directed towards determining the commercial viability of new products and processes. For example, finite element analysis and simulation software packages provide data for advanced graphic displays used in applications ranging from the manufacture of artificial limbs to the simulation of launch sequences for offshore drilling rigs.

A two-year joint research venture with Intera Technologies Ltd. has produced a new product called "STAR-VUE". This system will augment Intera's marketing of their STAR airborne radar systems. Intera's synthetic aperture radar system is carried in an aircraft and flown over ice infested waters. Vessels moving through these waters, or fixed platforms such as drilling rigs, require data on ice conditions and ice movements. A high-flying aircraft acquires these data and transmits them to the "STAR-VUE" system which might be on the bridge of an icebreaker. Together with the marine radar, the system gives the ship's crew an updated and broad picture of ice conditions affecting their route selection.

Nortech Surveys (Canada) Inc. and the Alberta Research Council have completed a two-year joint research venture resulting in an airborne laser mapping system which is being used for topographical mapping work. The system, now in use internationally, is able to produce quickly and inexpensively, accurate maps of rough terrain covered by foliage. This joint venture has also developed aspects of Global Positioning Satellite System technology pertinent to accurately producing real-time aircraft positioning and very precise land positioning. The current system is able to obtain accurate positions in latitude, longitude, and height above sea level when operated in a static mode.

Precision can be as good as a few centimetres. Work is continuing with Nortech Surveys to apply these same methods to the dynamic case of aircraft positioning.

The joint research venture with Q.C. Data Collectors Ltd., active since early 1985, is related to technology that automatically digitizes documents such as maps. The system takes data from a general map and separates the features of interest such as contours, roads, and drainage systems. This information, in its digital format, is very useful in applications where these various "layers" of maps need to be manipulated, such as in seismic acquisition programs or land use planning. This project will produce an inexpensive workstation which allows users to produce sets of files representing various features of general purpose maps. This project has reached a stage where the methodologies and techniques have been proven and efforts are being directed towards implementation.

A joint research venture between the Alberta Research Council and Veritas Software Ltd. started in June. This project concentrates on the 3-D tomographic representation of Vertical Seismic Profile (VSP) data combined with the more usual Common Depth Point (CDP) surface data. Another joint research venture which started in 1985, is with the D&S Petroleum Consulting group. This project will expand the capabilities of the company's LOG-MATE ESP computerized well log analysis system to develop an Expert System for well log analysis.

Biotechnology

The biotechnology pilot plant operations started at the Alberta Research Council's new building in south Edmonton. This pilot plant allows research to be done on the scaling up of biotechnology processes in fermentors that are from 2 litres to 1500 litres in size. Prior to 1985, the largest fermentor was 15 litres. The new facility also includes freeze drying and spray drying facilities, process tanks and holding tanks, a centrifuge system for harvesting from the fermentor, an analysis laboratory and computing facilities.

In October, the Government of Alberta approved funding of $2.6 million to establish a biotechnology toll production facility in conjunction with the pilot plant laboratory. One of the main features of this new facility will be a 15 000-litre fermentor, providing the only facility of its kind in Canada and the third in North America. This facility will give Alberta's biotech-

The first project completed in the biotechnology pilot plant was a contract for BIOFROST Inc., of Hamilton, Ontario, a Canadian subsidiary of Advanced Genetic Sciences Inc., of Berkeley, California.

The biotechnology pilot plant started operations during 1985 with a broad range of facilities. When it is fully developed, it will be the only biotechnology toll facility in Canada for use by industrial clients.

Researchers in the joint research venture with BIO LOGICALS inc., of Toronto, reached a milestone by cloning and producing a protein in yeast cells, rather than animal cells, for use in insulin preparations and other health care applications.

A joint research venture of the Alberta Research Council and BIO LOGICALS inc., a biotechnology company in Toronto, has been engaged in genetic engineering applied to the pharmaceuticals field.

nology companies a competitive advantage in the production and entry of new products into world markets and will attract international business to the province. The new toll production facility will allow the Alberta Research Council to provide a complete range of support to clients, from the discovery of new products to large scale production.

The first project completed in the biotechnology pilot plant was a contract for BIO-FROST Inc., of Hamilton, Ontario, a Canadian subsidiary of Advanced Genetic Sciences Inc., of Berkeley, California. The project was to develop a commercial production process for SNOMAX, ice-inducing bacteria used in snow making. The Alberta Research Council completed the process development, scaling up from the fermentor of 2 litres to that of 1500 litres. The product is now in the early phases of production.

As a joint research venture of the Alberta Research Council and BIO LOGICALS inc., a biotechnology company in Toronto, has been engaged in genetic engineering applied to the pharmaceuticals field. The aim of the project is to explore an organism more advanced than a bacterium or a yeast, in this case slime mould, to determine whether it has the potential for producing specified proteins from other organisms. The slime mould is also being studied in the pilot plant to determine its characteristics for commercial production. In 1985, several plasmids were constructed which will allow an assessment of the potential of this system to produce foreign proteins in a more efficient way.

The joint research venture program reached a milestone in 1985 by cloning and producing protamine in yeast cells. Protamine, which is extracted from salmon tissue, is currently used in insulin preparations to prolong the effects of insulin, and is also used to restore the clotting of blood which has been thinned by anticoagulants during surgery.

A magnification by 200 times of the slime mould, Dictyostelium discoidem, *which is considered a good system for producing commercial quantities of protein.*

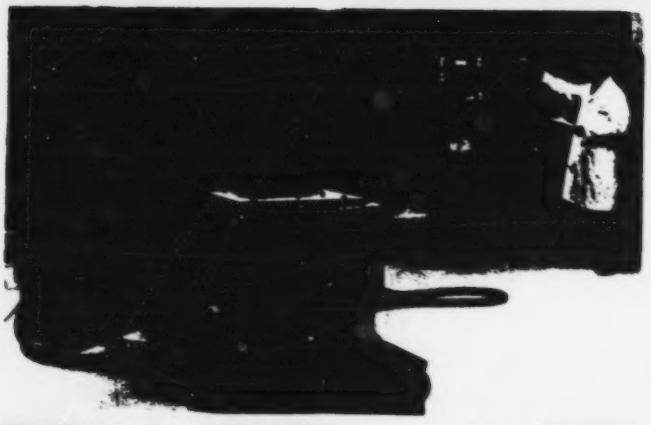
Electronics Test Centre

Engineers adjust two chambers used for temperature and humidity cycling to determine the effects of thermal stress on electronic product performance.

The Electronics Test Centre will provide testing services to electronic and telecommunications product manufacturers requiring product certification in either Canada or for international markets such as the United States, Japan, Singapore, Great Britain, and West Germany.

To encourage and stimulate the electronics, telecommunications and high technology industries in the province, the Government of Alberta established the $10.6 million Electronics Test Centre, under the auspices of the Alberta Research Council. Funding for the development of the Test Centre has come from a special Alberta Heritage Savings Trust Fund capital grant, and net operating costs are covered by grant funding. The Electronics Test Centre will provide testing services to electronic and telecommunications product manufacturers requiring product certification in either Canada or for international markets such as the United States, Japan, Singapore, Great Britain, and West Germany.

The test centre designed and completed fit-up of its facilities in the Alberta Research Council's building in southeast Edmonton, completed construction of the electromagnetic interference open field test site, and purchased, installed and commissioned test equipment. It has recruited an outstanding management and technical staff of sixteen people. Hon. Hugh Planche, Minister of Economic Development, officially opened the test centre on December 5, 1985.



An electronic product prepared for vibration testing can be subjected to simultaneous thermal and dynamic testing closely simulating their end-use conditions.

This enclosed structure allows radiated emission testing to be performed year-round at the open field site. Because no reflective surfaces are permitted above the metal ground plane, no metallic materials were used in the construction.

The test centre has the capability of providing testing services in product safety, failure analysis, terminal attachment, environmental testing, vibration testing, EMI/EMC RF anechoic chamber testing, and EMI/EMC open field testing. Accreditation has

The automated terminal attachment test system, one of the most advanced systems of its kind in Canada, is used to certify any product to be connected to the public switched telephone network.

Business development efforts have resulted in more than $200 000 in contracts either completed or nearing final stages of negotiation.

been sought, and in some cases received, from the following organizations: Standards Council of Canada, Department of National Defense; Department of Communications; the United States Federal Communications Commission. To ensure optimum service to industry for product safety testing, a special working arrangement with the Canadian Standards Association is being established.

Business development efforts have resulted in more than $200 000 in contracts either completed or nearing final stages of negotiation.

Bilateral arrangements have been negotiated for the mutual acceptance of test data and technical exchange and cooperation with Japan Machinery & Metals Inspection Institute (JMI) and Singapore Institute of Standards and Industrial Research (SISIR).

Patents and publications

Valid patents

Ruminant feed supplement and process for producing same
Diner, U. and R.M. Elofson

Hydrogen reduction of ferrous chloride
Rigg, T. and C.P. Gravenor

Method of transporting a substance along a pipeline
Kruyer, J.

Seedling container
Creighton, S.M., D.L. Mitchell and W.C. Kay

Method of preparation of coal for safe transport and storage
Berkowitz, N. and J.G. Speight

Article passing rotary seal
Jensen, E.J. and L.M. White

Method of feeding ruminants N-Glucosyl-N'-Hydroxymenthylurea
Elofson, R.M., L.P. Milligan, J. Wohllebe and M. Worsley

Method of transporting oil and natural gas along a pipeline
Jensen, E.J., R.A.S. Brown and E.J. Wiggins

Transition metal catalyst
Gadallah, F. and R.M. Elofson

Regeneration process for poisoned claus alumina catalyst
George, Z.M.

Arc welding
Roen, R.A.

Process for recovering bitumen from tar sand
Kruyer, J.

Desulfurization of fluid coke
George, Z.M.

Beneficiation process for oxidized iron ore
Bertram, E.F. and P. Harris

Apparatus for progressively removing layers or overburden from an inclined side of a cut
Owen, H.D. and T. Smith

Treatment of oil sands slimes and modified bitumen recovery process
Kessick, M.A.

Pipeline transportation of heavy crude oil
Kessick, M.A. and C.E. St. Denis

Formation of coke from heavy crude oils in the presence of calcium carbonate

Kessick, M.A., Z.M. George and L.G. Schneider

In-situ formation of oil-in-water emulsion from bituminous oil deposits
Kessick, M.A., C.E. St. Denis and D.J. Currie

Lime addition to heavy crude oils prior to coking
Kessick, M.A., Z.M. George and L.G. Schneider

Coal liquefaction process with oil sand bitumen derived solvent
Moschopedis, S.E.

Enhanced oil recovery using electrical means
Sacuta, A.

Process for the preparation of trans-3-formylbut-2-enenitrile
Chen, S.C. and J.M. MacTaggart

Production of metallurgical coke from oxidized caking coal
Ignasiak, B.

Hydrodesulfurization of coke
George, Z.M.

Combination solvent injection-electric current application method for establishing fluid communication through heavy oil formation
Sacuta, A.

Regeneration process for poisoned claus alumina catalyst, including NaOH activation
George, Z.M.

1985 publications

Bulletins

Aggregate resources of the Edmonton/Lloydminster region
Edwards, W.A.D., R.B. Hudson and D.W. Scafe
Bulletin 47

Geology of the Athabasca group in Alberta
Wilson, J.A.
Bulletin 49

Oil sands geology — Athabasca deposit north
Flach, P.D.
Bulletin 46

Petrographic studies of coals from Alberta plains
Parkash, S.
Bulletin 50

Reports

Coal quality and rank variation within Upper Cretaceous and Tertiary sediments, Alberta plains region
Nurkowski, J.R.
Earth Sciences Report 85-1

Evaluations of Alberta plains coals for pyrolysis and liquefaction process
Chakrabartty, S.K.
Coal Report 85-1

Spatial and temporal variations in groundwater chemistry of shallow aquifers in the Sand River area, Alberta
Wallick, E.
Earth Sciences Report 84-8

Contribution Series

1318
Five coordinate dicarbonyl carbonyl complexes of rhodium (I): [RhX(CO)$_2$(PPh$_3$)$_2$] (X = Cl, Br, I)
Sanger, A.R.

1319
Mass transfer limitations in coal liquefaction
Ozum, B., S. Parkash, S.K. Chakrabartty and M.N. Oguztoreli

1320
Hydroformylation using dinuclear rhodium catalyst precursors. Part 1. Numerical methods for the determination of the kinetic parameters
Southern, T.G.

1321
In situ measurement of pavement behavior under load
Christison, J.T.

1322
Ichnology of storm-influenced shallow marine sequence: Cardium Formation (Upper Cretaceous)
Pemberton, S.G., and R.W. Frey

1323
True density and elemental composition of subbituminous coals
Parkash, S.

1324
Search for low severity liquefaction concept
Chakrabartty, S.K.

1325
Description of drilling for subbituminous coal in the plains region of Alberta, 1961-1983
Bosman, A.

1326
Vapour liquid equilibrium calculations for dilute aqueous solutions of CO_2, H_2S, NH_3 and NaOH to 300°C
Roberts, B.E. and P.R. Tremaine

1327
The electric properties of the bitumen/water interface. Part II. Application of the ionizable surface group-model
Takamura, K. and R.S. Chow

1328
The sublimation of dry ice pellets used for cloud seeding
Kochtubajda, B. and E.P. Lozowski

1329
Crandallite group minerals in the Helikian Athabasca group in Alberta, Canada
Wilson, J.A.

1330
Lower Cretaceous Luscar Group (revised) of the northern and north central foothills of Alberta
Langenberg, C.W. and M.E. McMechan

1331
Control of ammonium concentration in *Escherichia coli* fermentations
Thompson, B.G., M.M. Kole and D.F. Gerson

1332
Conversion of chenodeoxycholic acid to ursodeoxycholic by *Clostridium absonum* in culture and by immobilized cells
Kole, M.M. and I. Altosaar

1333
Bicyclization of aza-compounds by positive halide ions. I. Cyclic amines
Laidler, J.K., R.M. Elofson and F.F. Gadallah

Results of publicly funded research projects are documented in technical publications produced and distributed by the Alberta Research Council.

Scientific staff have contributed numerous articles published in international journals.

1334
Injection-production strategies for reservoirs having a bottom water zone
Singh, B., J.D. Malcolm and T.R. Heidrick

1335
Separation of macerals from subbituminous coals and their response to liquefaction
Parkash, S., K. Lali, M. Holuszko and M.P. du Plessis

1336
On the gamma size distribution and stochastic sampling errors
Wong, R.K.W. and N. Chidambaram

1338
Visible light-induced splitting of hydrogen sulphide and thiol formation in CdS suspension
Green, M. and R.M. Elofson

1339
Heat transfer in axially dispersed two-phase flow systems
Ozum, B. and M.P. du Plessis

1340
Catalytic activity of faujasite-type zeolites towards the Claus reaction
George, Z.M. and R.W. Tower

1341
On the measurement of coal liquefaction kinetics
Ozum, B.

1342
Influence of lithology and fluid flow in the temperature distribution in a sedimentary basin: A case study from the Cold Lake area, Alberta
Bachu, S.

1343
Choose right rig for exploration
Edwards, W.A., J.C. Fox and R.J. Richardson

1344
Electrochemical pH control of *Saccharomyces cerevisiae* batch cultures
Thompson, B.G. and D.F. Gerson

1345
Characteristics of in situ coal gasification liquids from a Cretaceous coal
Chakrabartty, S.K. and M. Selucky

1346
Petrography of subbituminous coals from Alberta (Canada) Plains
Parkash, S. and K. Lali

1347
Nuclear magnetic resonance studies of asphaltenes and coals: A new approach to obtaining asphaltene structural parameters with dipolar dephasing
Cyr, N. and M.L. Selucky

1348
Hailstone size distributions and their relationship to storm thermodynamics
Cheng, L., M. English and R. Wong

1349
Use of radar to obtain intensity-duration estimates for rainstorms
Wojtiw, L., and S. Figliuzzi

1350
Electrokinetic flow in a parallel-plate channel containing bitumen and water: A model for oil sands
Sacuta, A., and K. Takamura

1351
Origin of the Pleistocene Key Largo Limestone, Florida Keys
Harrison, R.S., and M. Coniglio

1352
Electrochemical control of redox potential in batch cultures of *Escherichia coli*
Thompson, B.G.

1353
^{13}C Solid state NMR of Alberta subbituminous macerals
Parkash, S.

1354
The apparent molar heat capacity of aqueous hydrochloric acid from 10 to 140 °C
Tremaine, P.R.

1355
Approximate MRPP-P values obtained from four exact moments
Wong, R.

1356
Laboratory study of solvent enhanced communication in oil sands
Isaacs, E.E., and K. Green

1357
The physical environment in relation to high frequency callus and plantlet development in anther cultures of wheat *(Triticum aestivum L.)* cv. Chris
Lazar, M.D., G.W. Schaeffer and P.S. Baenziger

1358
The geometry of folded and thrusted rocks in the Rocky Mountain Foothills near Grande Cache, Alberta
Langenberg, C.W.

1359
Use of a mill and spinning riffle for sub-sampling laboratory samples of oil sands
Wallace, D.

1360
Thermodynamics of the complexes of aqueous iron (III), aluminum, and several divalent cations with EDTA: Heat capacities, volumes, and variations in stability with temperature
Hovey, J.K., and P.R. Tremaine

1361
Heat transfer in two-phase flow system
Ozum, B.

1362
Commercial evaluation of regenerated Claus alumina catalyst
George, Z., M.M. Schurek and B. Theriault

1363
Silica transport during steam injection into oil sands. I. Dissolution and precipitation kinetics of quartz: new results and review of existing data
Bird, G., J. Boon and T. Stone

1364
Effects of carbon dioxide concentration on anaerobic fermentations of *Escherichia coli*
Thompson, B.G.

1365
On the measurement of coal liquefaction kinetics
Ozum, B.

Financial statements

ALBERTA LEGISLATURE
OFFICE OF THE AUDITOR GENERAL

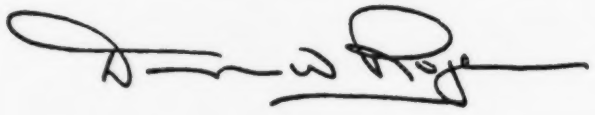
Auditor's Report

To the Board of Directors of
the Alberta Research Council

I have examined the balance sheet of the Alberta Research Council as at March 31, 1985 and the statement of revenue, expenditure and operating funds for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances, except as explained in the following paragraph.

As disclosed in Note 3 to the financial statements, the Council has entered into research contracts which specify that the Council does not receive title to fixed assets purchased until completion of the contract or at the discretion of the sponsor. Since the Council did not identify those fixed assets to which it may not have title, I was unable to determine if any adjustment might be required to the balance sheet to adjust fixed assets and contributed surplus to reflect ownership of the assets.

In my opinion, except for the effect of adjustments, if any, which I might have determined to be necessary had I been able to identify assets to which the Council may not have title as described in the preceding paragraph, these financial statements present fairly the financial position of the Council as at March 31, 1985 and the results of its operations for the year then ended in accordance with the disclosed basis of accounting, considered appropriate in the circumstances, as described in Note 2 to the financial statements applied on a basis consistent with that of the preceding year.



F.C.A.
Auditor General

Edmonton, Alberta
September 25, 1985

Alberta Research Council
Balance Sheet
as at March 31, 1985
(thousands of dollars)

Assets	**1985**	1984
Current:		
Cash	$14,181	$ 5,799
Accounts receivable	5,118	3,936
Prepaid expenses	539	386
Advances to joint ventures	487	553
	20,325	10,674
Fixed:		
Equipment (Note 3)	27,208	22,979
	47,533	33,653
Trust Fund:		
Cash	178	398
	$47,711	$34,051
Liabilities and Equity		
Current:		
Accounts payable	$ 3,745	$ 2,333
Deferred contract revenue	2,954	1,371
Obligation under capital lease	157	78
	6,856	3,782
Non-current:		
Obligation under capital lease	-	157
Equity:		
Contributed surplus	27,051	22,744
Operating funds (Note 4)	9,822	6,774
Restricted surplus (Note 5)	3,804	196
	40,677	29,714
	47,533	33,653
Trust Fund:		
Trust liability (Note 6)	178	398
	$47,711	$34,051

The accompanying notes are part of these financial statements.

Alberta Research Council
Statement of Revenue, Expenditure and Operating Funds
for the year ended March 31, 1985
(thousands of dollars)

Revenue	**1985**	1984
Grants from:		
Province of Alberta, Department of Executive Council:		
Alberta Research Council	$21,327	$19,753
Electronics Test Centre	1,461	-
Office of Science and Technology	136	197
Alberta Heritage Savings Trust Fund:		
Electronics Test Centre	4,225	-
Contract revenue:		
Alberta Research Council	19,979	19,015
Office of Science and Technology	15	-
	47,143	38,965
Expenditure		
Natural Resources Division	12,753	12,107
Energy Resources Division	11,083	10,932
Administration Division	5,423	4,230
Applied Sciences Division	5,284	6,445
Industrial and Engineering Research Division	2,569	2,833
Electronics Test Centre	2,080	-
Executive offices	1,146	826
Office of Science and Technology	149	140
	40,487	37,513
Revenue over expenditure for the year	6,656	1,452
Less: Transfer to restricted surplus (Note 5)	3,608	57
	3,048	1,395
Operating funds at beginning of year	6,774	5,379
Operating funds at end of year	$ 9,822	$ 6,774

Alberta Research Council
Notes to the Financial Statements
March 31, 1985

Note 1 Authority
The Alberta Research Council operates under the authority of the Alberta Research Council Act, Chapter A 35.1, Statutes of Alberta 1981.

Note 2 Summary of Significant Accounting Policies and Reporting Practices
(a) General
These financial statements have been prepared in accordance with generally accepted accounting principles except that no provision for depreciation on fixed assets has been made. Purchases of operating fixed assets are charged to operations in the year and are shown on the balance sheet at original cost or at estimated cost with the offsetting credit to contributed surplus.

(b) Capital Lease
Assets acquired under capital leases, which transfer to the Council substantially all the benefits and risks incident to ownership of the assets, are initially recorded as fixed assets at cost and the related lease obligations are recorded as liabilities. The lease obligations are reduced and contributed surplus increased by a corresponding amount over the lease term as lease payments are made.

(c) Advances to Joint Ventures
Advances to joint ventures are recorded as assets of the Council. The asset is reduced and a corresponding charge is made to expenditure for the Council's share of joint venture expenses.

(d) Occupancy and Office Furniture Expenditure
Occupancy and office furniture have been provided by the Province of Alberta at no cost and are not reflected in these financial statements.

(e) Patents
Expenditures for patents owned by the Council as a result of research activity are not capitalized due to the intangible nature of assets that may accrue to the Council.

(f) Investment
The Council is a majority shareholder of Alberta Helium Limited. This company was formed to conduct research and has no significant tangible net assets. The Council's equity in the company is not reflected in these financial statements. (See Note 8.)

(g) Contract Revenue Recognition
Contract revenue is recognized as costs are incurred, up to the contract maximum and in accordance with contracted cost sharing ratios. Revenue will be deferred to future years when it is known losses will be incurred on projects.

(h) Changes in Financial Position
A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Fixed Assets
Fixed assets purchased subsequent to April 1, 1981 have been valued at cost. Those purchased prior to April 1, 1981 have been valued at estimated cost by the Council.

	1985	1984
Balance at beginning of year	$22,978,784	$19,355,537
Additions at cost	4,350,396	3,623,247
	27,329,180	22,978,784
Disposals	120,826	-
Balance at end of year	**$27,208,354**	$22,978,784

Included in fixed assets are certain fixed assets purchased as a result of research contracts which specify that the Council does not receive title to the fixed assets purchased until completion of the contract or at the discretion of the sponsor.

The difference between contributed surplus and fixed assets as disclosed on the balance sheet is represented by an obligation under capital lease.

Note 4 Operating Funds
Operating funds are required for $2,933,000 of outstanding commitments at March 31, 1985, $1,232,000 of capital assets for the new Mill Woods facility and working capital requirements of the Council.

Note 5 Restricted Surplus

Revenue and expenditure of the Council includes the following amounts for the Electronics Test Centre and Office of Science and Technology:

	Electronics Test Centre	Office of Science and Technology	Total
Revenue			
Grants from: Province of Alberta, Department of Executive Council	$1,461,000	$136,000	$1,597,000
Alberta Heritage Savings Trust Fund	4,225,000	-	4,225,000
Contract revenue	-	15,000	15,000
	5,686,000	151,000	5,837,000
Expenditure			
Manpower	114,616	100,664	215,280
Supplies and services	1,270,312	48,048	1,318,360
Fixed assets	665,606	218	665,824
Overhead	29,102	-	29,102
	2,079,636	148,930	2,228,566
Surplus for the year, transferred to restricted surplus	3,606,364	2,070	3,608,434
Restricted surplus at beginning of year	-	195,764	195,764
Restricted surplus at end of year	$3,606,364	$197,834	$3,804,198

Restricted surplus is to be used only for future expenditures related to the Electronics Test Centre and the Office of Science and Technology. Previously, surpluses relating to the Office of Science and Technology were recorded as trust funds. At the year end, the Council has outstanding commitments amounting to $2,260,000 for the Electronics Test Centre.

Note 6 Trust Liability

Trust funds are contributions received from other government departments under research agency agreements which specify that the Council is to administer the contributions and provide accounting services.

	1985	1984
Balance at beginning of year	$ 397,927	$1,977,833
Contributions	1,312,823	1,806,271
	1,710,750	3,784,104
Expenditure	1,533,240	3,386,177
Balance at end of year	$ 177,510	$ 397,927

Note 7 Contingent Liabilities

The Council is a defendant in a number of legal proceedings. Claims against the Council in these proceedings, which have not been reflected in the accounts, amounted to $886,000 as at March 31, 1985. While the ultimate outcome of these proceedings cannot be predicted at this time, it is the opinion of management that the disposition of these cases will have a minor effect on the financial position of the Council.

Note 8 Subsequent Event

On August 29, 1985, the shareholders of Alberta Helium Limited agreed that the Company would issue additional shares for cash and "know-how". As a result, the Council's equity in Alberta Helium Limited was reduced to 38.2% and future share issues are expected to reduce the Council's equity to 21.5% by July 1, 1987.

Note 9 Comparative Figures

The 1984 figures have been restated where necessary to conform to 1985 presentation.

Note 10 Approval of Financial Statements

These financial statements were reviewed by management and recommended to the Board for approval.

Actual cost by major research activity for the year ended March 31, 1985 ($000)

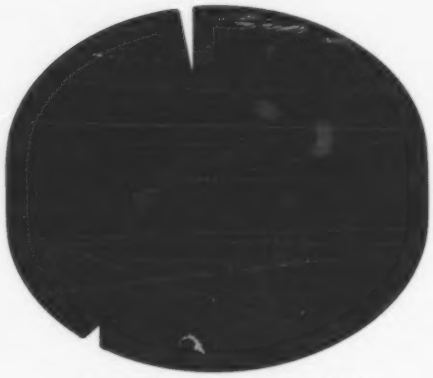
(Not including the Electronics Test Centre and the Office of Science and Technology)

Natural resources	7936
	7206
	$15142
Oil sands	3689
	4796
	$8485
Coal	2451
	2417
	$4868
Industrial & engineering	2014
	1037
	$3051
Applied sciences	5237
	1474
	$6711
	$38257

Natural resources $15,142

Oil sands $8485

Coal $4868



Industrial & engineering $3051

Applied sciences $6711

Expenditures ($000)

Manpower	$23071 (60%)
Supplies and services	$11328 (30%)
Fixed assets	$3858 (10%)

Sources of funds ($000)

Government Grant	$21327 (52%)
Contracts	$19979 (48%)

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Minister of Economic Development

*THE HONORABLE D. JOHNSTON
Minister of Advanced Education

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Vice-President, Research Division, Research and Engineering Department, Esso Petroleum Canada, Sarnia Ontario

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Vice-President (Research), University of Alberta, Edmonton

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Manager, Technical Services, Alberta Energy Company Ltd., Calgary

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Interim Director of Research Administration and Dean of Arts and Science, University of Lethbridge, Lethbridge

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MR. R.R. WATT
Group Vice-President, Transmission, Northern Telecom Canada Ltd., Edmonton

DR. R.W. STEWART[1,2]
President, Alberta Research Council, Edmonton

*Retired from the Board of Directors. By Order-in-Council, the following people were appointed to the Board of Directors in 1986:

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Former Chief (ret.) Defence Research Establishment, Suffield, Medicine Hat

MR. J.R. MCDOUGALL
President, DALCOR Innoventures Ltd., Edmonton

DR. G.B. MILLER
President and Director of Research, Nova Husky Research Corporation Ltd., Calgary

DR. I.E. TEITZ
Clinical Laboratory Scientist, Calgary General Hospital, Calgary

[1]Executive committee
[2]Salary schedule advisory committee

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President

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Vice-President, Operations

MRS. D.M. HOLLANDS
Corporate Secretary and Director of Public Relations

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Vice-President, Natural Resources Division

MR. W.J. CHERPETA
Vice-President, Finance and Administration Division

DR. D.J. CURRIE
Vice-President, Applied Sciences Division

DR. J.G. DOUGLAS
Vice-President, Energy Resources Division

DR. D.L. MITCHELL
Vice-President, Industrial & Engineering Research Division
and Regional Vice-President, southern Alberta

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tel. (403) 450-5111

Calgary Office:
3rd floor
6815 - 8 Street NE
Calgary, Alberta
Canada T2E 7H7
tel. (403) 297-2600

Alberta Research Council staff*

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Secretary to the President: J.A. BOOTH, B.Ed. (Alberta).
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Secretarial Staff: T.V. KURELUK; B. COULOMBE.

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Secretarial Staff: S.V. STADLER.

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Technical Staff: L.K. EIZENPORTH; R.P. ERKAMP.

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Support Staff: D. LETANG; D. PYKE.

Electronics Test Centre

General Manager: B.G. YOUNG, B.Sc. (London Technical College).
Professional Staff: J.M. BEDDOES, B.Sc. (London); J. POPA, M.Sc. (Bucharest); J.Z. RYMKIEWICZ, B.Sc. (Technical University of Gdansk); I.Z. SALEH, B.Sc. (Alexandria); D. SCOTT, B.Sc. (Manitoba); G. ZACKOWSKI, M.Sc. (Alberta).
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*1 December 1985

Brunswick); B. OZUM, Ph.D. (Virginia); S. PARKASH, Ph.D. (Punjab); R. PARKER, M.Sc. (Alberta); W. PAWLAK, Ph.D. (Poznan); M. SELUCKY, Ph.D. (Masaryk); T.G. SOUTHERN, D.Sc. (Rennes); A. TURAK, M.Sc. (Alberta).
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